Department of Computer Science & Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

M.Tech Computer Science and Engineering

Programme Educational Objectives (PEOs)

PEO1: Students are trained in such a way that makes them capable of exploiting and enhancing theoretical and practical knowledge in various domains of Computer Science.

PEO2: Students are imparted with strong base of knowledge that makes them suitable for both industry teaching and research.

PEO3: Students are trained to develop practical and efficient solutions to the challenges in the growing field of software industry to gain leadership positions in their organization and/or teams.

PEO4: Students are inculcated with the sensitivity towards ethics, public policies and their responsibilities towards the society to gain trust and respect of others as ethical team members.

PROGRAM OUTCOMES (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: In depth understanding of fundamental principles and concepts of various domains of Computer Science.

PO5: Ability for analytical and critical thinking in order to analyse, design and improve existing tools and techniques.

PO6: Knowledge of contemporary issues in the field of Computer Science and ability to engage in lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

On successfully completing the program a graduate shall

PSO 1: Possess ability to assimilate an in depth understanding of fundamental principles and concepts of various domains of Computer Science, communication, networking, and other relevant areas.

PSO 2: Have the ability for analytical and critical thinking for real world problems, design using their technical knowledge and improve existing tools and techniques.

PSO 3: Gain knowledge of contemporary issues in the field of Computer Science and acquire the ability to engage in lifelong learning.

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI

NEW COURSE STRUCTURE – WEF academic session 2025-26

Based on CBCS & OBE model

Recommended scheme of study for M.Tech. (Computer Science & Engineering)

SEMESTR / Session of Study (Recommended)	**Course Level**	**Category of Course**	**Course Code**	**Courses**	**Mode of delivery & credits*L-Lecture; T-Tutorial; P- Practicals***			**Total Credits*C-Credits***
					L (*Periods/ week*)	T *(Periods /week)*	P *(Periods /week)*	C
	THEORY							
FIRST /Monsoon	Fifth	Programme Core (PC)	CS531	Data Structures andAlgorithms	3	0	0	3
			CS532	Image Processing	3	0	0	3
			CS534	Internet of Things	3	0	0	3
			CS539	Data Mining and Data Warehousing	3	0	0	3
			CS541	Applied Cryptography	3	0	0	3
								15
		LABORATORIES						
	Fifth	Programme Core (PC) Lab	CS550	Data Structures andalgorithms Lab	4	0	0	2
			CS554	Image Processing Lab	4	0	0	2
			MT132	Communication Skill-I	0	0	3	1.5
								5.5
		TOTAL						15+5.5= 20.5

SECOND / Spring	Fifth	Programme Elective (PE)		PE I	3	0	0	3
				PE II	3	0	0	3
				PE III	3	0	0	3
				PE IV	3	0	0	3
				PE V	3	0	0	3
								15
		LABORATORIES						
	Fifth	Programme Elective (PE)Lab		PE I Lab	0	0	4	2
				PE II LAB	0	0	4	2
			MT133	Communication Skill-II	0	0	3	1.5
		TOTAL						15+5.5 =20.5
TOTAL FOR FIFTH LEVEL								20.5+20.5 =41
THIRD /Monsoon	Sixth	Programme Core (PC)	CS600	Thesis Part I				8
		Open Elective(OE)	*	OE 1/MOOC-I	3	0	0	3
		Open Elective(OE)	*	OE 2/MOOC-II	3	0	0	3
		TOTAL						8+6=14
FOURTH / Spring	Sixth	Programme Core (PC)	CS650	Thesis Part II				16
		TOTAL						16
TOTAL FOR SIXTH LEVEL								14+16= 30
GRAND TOTAL FOR M.TECH. PROGRAMME (46 + 24)								71

Open Elective List for M. Tech Program

Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P- Practicals*			Total Credits *C-Credits*
IT570	Basics of Python Programming	0	1	4	3

List of Electives

SPECIALIZATION I: Machine Learning

Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P- Practicals*			Total Credits *C-Credits*
CS630	Modern Optimization Techniques	3	0	0	3
CS631	Deep Learning	3	0	0	3
CS632	Data Analysis and Interpretation	3	0	0	3
CS633	Natural Language Processing	3	0	0	3
CS635	Reinforcement Learning	3	0	0	3
CS636	Evolutionary Computing	3	0	0	3
CS638	Computational Network Analysis	3	0	0	3

SPECIALIZATION II: Image Processing and Computer Vision

Course Code	**Courses**	**Mode of delivery & credits** ***L-Lecture; T-Tutorial; P- Practicals***			**Total Credits** ***C-Credits***
CS660	Content based Image Retrieval	3	0	0	3
CS661	Machine Learning for Computer Vision	3	0	0	3
CS662	Computer Vision	3	0	0	3
CS664	GPU Computing	3	0	0	3
CS666	Data Compression	3	0	0	3
CS667	Signal Processing	3	0	0	3
CS668	Digital video processing	3	0	0	3

SPECIALIZATION III: Network Security

Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P- Practicals*			Total Credits *C-Credits*
CS670	Biometric Security	3	0	0	3
CS672	Cyber Security and Digital Forensics	3	0	0	3
CS673	Data Compression Techniques	3	0	0	3
CS674	Introduction to Blockchain Technology	3	0	0	3
CS676	Security in Cyber Physical Systems	3	0	0	3
CS677	Quantum Cryptography	3	0	0	3

Program Elective Labs

Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P- Practicals*			Total Credits *C-Credits*
CS680	Matlab Programming	0	0	4	2
CS682	Python Programming	0	0	4	2
CS639	Deep learning Lab	0	0	4	2
CS640	Data Analytics Lab	0	0	4	2
CS663	Computer Vision Lab	0	0	4	2
CS665	GPU Computing Lab	0	0	4	2
CS671	Biometric Security Lab	0	0	4	2
CS675	Introduction to Blockchain Technology Lab	0	0	4	2

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI

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Based on CBCS & OBE model

Recommended scheme of study for M.Tech. (Computer Science & Engineering)

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FIRST /Monsoon	Fifth	Programme Core (PC)	CS531	Data Structures andAlgorithms	3	0	0	3
			CS532	Image Processing	3	0	0	3
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			CS539	Data Mining and Data Warehousing	3	0	0	3
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								15
		LABORATORIES						
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			MT132	Communication Skill-I	0	0	3	1.5
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		TOTAL						15+5.5= 20.5
SECOND / Spring	Fifth	Programme Elective (PE)		PE I	3	0	0	3
				PE II	3	0	0	3
				PE III	3	0	0	3

				PE IV	3	0	0	3
				PE V	3	0	0	3
								15
		LABORATORIES						
	Fifth	Programme Elective (PE)Lab		PE I Lab	0	0	4	2
				PE II LAB	0	0	4	2
			MT133	Communication Skill-II	0	0	3	1.5
		TOTAL						15+5.5 =20.5
TOTAL FOR FIFTH LEVEL								20.5+20.5 =41
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IT570	Basics of Python Programming	0	1	4	3

List of Electives

SPECIALIZATION I: Machine Learning

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CS631	Deep Learning	3	0	0	3
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CS633	Natural Language Processing	3	0	0	3
CS635	Reinforcement Learning	3	0	0	3
CS636	Evolutionary Computing	3	0	0	3
CS638	Computational Network Analysis	3	0	0	3

SPECIALIZATION II: Image Processing and Computer Vision

Course Code	**Courses**	**Mode of delivery & credits** ***L-Lecture; T-Tutorial; P- Practicals***			**Total Credits** ***C-Credits***
CS660	Content based Image Retrieval	3	0	0	3
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CS662	Computer Vision	3	0	0	3
CS664	GPU Computing	3	0	0	3
CS666	Data Compression	3	0	0	3
CS667	Signal Processing	3	0	0	3
CS668	Digital video processing	3	0	0	3

SPECIALIZATION III: Network Security

Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P- Practicals*			Total Credits *C-Credits*
CS670	Biometric Security	3	0	0	3
CS672	Cyber Security and Digital Forensics	3	0	0	3
CS673	Data Compression Techniques	3	0	0	3
CS674	Introduction to Blockchain Technology	3	0	0	3
CS676	Security in Cyber Physical Systems	3	0	0	3
CS677	Quantum Cryptography	3	0	0	3

Program Elective Labs

Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P- Practicals*			Total Credits *C-Credits*
CS680	Matlab Programming	0	0	4	2
CS682	Python Programming	0	0	4	2
CS639	Deep learning Lab	0	0	4	2
CS640	Data Analytics Lab	0	0	4	2
CS663	Computer Vision Lab	0	0	4	2
CS665	GPU Computing Lab	0	0	4	2
CS671	Biometric Security Lab	0	0	4	2
CS675	Introduction to Blockchain Technology Lab	0	0	4	2

SEMESTER I

COURSE INFORMATION SHEET
Course code: CS531
Course title: DATA STRUCTURES AND ALGORITHIMS
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	Choose appropriate data structures and ADT/libraries.
2.	Design algorithms for a specific problem using the data structures and libraries.
3.	Understand the necessary mathematical abstraction to solve problems.
4.	Familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
5.	Come up with analysis of efficiency and proofs of correctness.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Develop an understanding of asymptotic notation and basic data structures.
CO2	Develop an understanding of the implementation of linear data structures.
CO3	Develop and analyze algorithms for non-linear structures.
CO4	Interpret the basic working of sorting techniques.
CO5	Develop an ability to understand the working of graphs and traversal methods.

SYLLABUS

Module 1: [8L]

Fundamental Data Structures: Definition, Structure and Properties of Algorithms, Asymptotic Analysis, Solving recurrences, Arrays, Singly Linked Lists, Circularly Linked Lists, Doubly Linked Lists.

Module 2: [8L]

Stacks, Queues, Dequeues: Simple Array Based Stack, Queue, Dequeue Implementation, Implementing Stack, Queue with Singly Linked List, Reversing an Array using Stack, Matching Parenthesis, A Circular Queue.

Module 3: [8L]

Trees: General Trees, Binary Trees, Implementing Trees, Tree Traversal Algorithms, Binary Search Trees, M-way search trees, AVL Trees, B Trees, B+ Trees.

Module 4: [8L]

Sorting: Merge sort, Quick sort, Comparing Sorting Algorithms. Heap: Priority Queues, Array Implementation of Heaps, Construction of Heaps, Heap Sort.

Module 5: [8L]

Graphs: Data Structures for graphs, Graph Traversals, Transitive Closure, Directed Acyclic Graphs, Shortest Paths, Minimum Spanning Trees.

Text Books:

1. Klein Shmuel Tomi, Basic Concepts in Data Structures, Cambridge University Press, 1st Edition, 2016.
2. Goodrich Michael T., Tamassia Roberto, Goldwasser Michael H. “Data Structures and Algorithms in Java”, Wiley, 6th Edition, 2014.

Reference Books:

1. G A V Pai – Data Structures and Algorithms: Concepts, Techniques and Applications, 2nd Edn, Tata McGraw-Hill, 2008.
2. Horowitz E.Sahni, S., Susan A., Fundamentals of Data Structures in C, 2nd Edition, University Press, 2010.
3. J. P. Tremblay , P. G. Sorenson – An Introduction to Data Structures With Applications, 2nd Edn, McGraw-Hill, Inc. New York, NY, USA.
4. Seymour Lipschutz – Data Structures, 6th Edn, 9th Reprint 2008, Tata McGraw-Hill.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	low	medium	high	medium	medium
CO2	medium	medium	medium	high	high	medium
CO3	medium	medium	high	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS532
Course title: IMAGE PROCESSING TECHNIQUES
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	Understand the basic concept of Digital Image Processing.
2.	Learn the Fourier, Transform & its application.
3.	Understand the basic components of filters.
4.	Understand the basic concept of Image Compression Fundamentals.
5	Understand the basic concept of Image Segmentation.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Develop an understanding of image formation and digitization.
CO2	Be able to apply spatial-based filtering techniques.
CO3	Be able to apply frequency-domain filtering techniques.
CO4	Synthesize a solution to image compression using the concept of information theory and lossless and lossy compression techniques.
CO5	Design and create practical solutions for common image processing problems.

SYLLABUS

Module 1: Introduction to Digital Image Processing [8L]

Introduction to Digital Image Processing, Elements of Visual Perception, Image Sensing & Acquisition, Sampling and Quantization, Basic Relationships between Pixels.

Module 2: Filtering in the Spatial Domain [8L]

Intensity Transformations, Histogram Processing, Spatial Convolution & Correlation, Smoothing Spatial Filters, Sharpening Spatial Filters, Order Statistic Filters.

Module 3: Filtering in the Frequency Domain [8L]

Introduction to the Fourier Transform, Discrete Fourier Transform, Properties of the Two Dimensional Fourier Transform, Image Smoothing using Frequency Domain filters, Image Sharpening using Frequency Domain filters, Selective Filtering, Basics of Fast Fourier Transform, Basics of: Walsh-Hadamard Transform; K-L Transform; Discrete Cosine Transform.

Module 4: Image Compression [8L]

Image Compression Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria, Image Compression Models– Source Encoder and Decoder, Channel Encoder and Decoder, Elements of Information Theory, Error-Free Compression – Variable-Length Coding, Bit-Plane Coding, Lossless Predictive Coding. Lossy Compression – Lossy Predictive Coding, Transform Coding.

Module 5: Image Segmentation [8L]

Image Segmentation- Fundamentals, Point, Line and Edge Detection, Thresholding, Region Based Segmentation, Segmentation based on color.

Text Books:

1. Rafael. C. Gonzalez & Richard E. Woods- Digital Image Processing, 3/e Pearson Education, New Delhi – 2009.

Reference books:

1. W.K.Pratt-Digital Image Processing, 4/e, John Wiley & sons, Inc. 2006.
2. M. Sonka et al. Image Processing, Analysis and Machine Vision, 2/e, Thomson, Learning, India Edition, 2007.
3. Jayaraman, Digital Image Processing, Tata McGraw-Hill Education, 2011.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium	medium	medium	medium	high
CO2	high	high	medium	high	high	high
CO3	high	high	high	high	high	high
CO4	high	high	medium	high	high	high
CO5	high	high	medium	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS539
Course title: DATA MINING AND DATA WAREHOUSING
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	Understand the need for data mining and the architectural requirements of performing effective data mining.
2.	Establish the purity or goodness of data and present them in easily comprehensible manner to targeted audiences.
3.	Understand the role a data warehouse plays in developing a consummate BI system.
4.	Differentiate between different implementation methods for data warehouses and compare their performances across common operations.
5	Understand association rule mining and areas of applications for such an activity.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Identify a data mining problem from a problem statement and formalize the dimensions and facts of the problem.
CO2	Choose suitable summarization and visualization tools to capture the patterns in a dataset and present them succinctly.
CO3	Be able to identify issues of data sanguinity and apply preprocessing and reduction techniques.
CO4	Design efficient and effective warehouse schema for simple data storage scenarios and extract summarized data from the warehouse
CO5	Represent non compatible datasets in forms amenable for association rule mining, extract rules and quantify their validity.

SYLLABUS

Module 1: Introduction to Data Mining [8L]

What is data mining? Kinds of data to be mined, Patterns and types of patterns, Technologies involved, Targeted Applications, Major issues and challenges.

Module 2: Working with data [8L]

Data objects and attribute types, Basic statistical description of data, Data Visualization, Measuring data similarity and dissimilarity

Module 3: Data Pre-processing [8L]

Why is data pre-processed? Data cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization

Module 4: Introducing Data Warehouses [8L]

Basic Concepts, Architecture of a data warehouse, ETL, Schemas, Dimensions, Measures, Concept Hierarchies, Basic OLAP operations, Efficient data cube computations, OLAP engines e.g. ROLAP, MOLAP, HOLAP

Module 5: Introduction to Association Rule Mining [8L]

Introduction, Support and Confidence, Data Representation, Apriori Method, FP Tree, Lift & Correlation

Text Books:

1. Jiawei Han, and Micheline Kamber, "Data Mining Concepts & Techniques", 3rd. Edition, Publisher Elsevier India Private Limited, 2015.
2. Mohammed J. Zaki, and Wagner Meira Jr., "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2016.
3. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, "Introduction to Data Mining", Pearson, 2014.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
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Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	low	medium	high	high	medium
CO2	high	high		medium	medium	high
CO3	medium	high	high	medium	high	low
CO4		medium	high		medium	high
CO5	low	medium	high	high	medium	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET

Course Code: CS541
Course Title: Applied Cryptography
Pre-requisite(s): Number Theory, Linear Algebra
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3 L
Class: M. Tech.
Semester / Level: I/ I
Branch: CSE

COURSE OBJECTIVES

This course envisions to impart the students to:

1.	Describe the principles of public key cryptosystems, hash functions, digital signature and classical encryption techniques.
2.	To acquire fundamental knowledge on the concepts of finite fields, number theory, prime and composite number.
3.	Understand various block cipher, stream cipher models and authentication systems.
4.	Describe the principles of threshold cryptosystem and digital certificates.
5.	Acquire fundamental knowledge on applications of protocol, PKCS, Cryptocurrency etc.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Compare various Cryptographic Techniques.
CO2	Understand security issues, practices and principles in various applications.
CO3	Learn to analyze the security of the in-built cryptosystems.
CO4	Develop cryptographic algorithms for information security.
CO5	Develop authentication schemes for identity and membership authorization.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Foundation Information security and cryptography, Classes of attacks and security models, Zero-Knowledge Proofs algorithm, Authentication and Identification, Private-key cryptography, Public-key cryptography, Digital Signatures, Blind Signature, Steganography, Watermarking	**6**
Module – II: Mathematical Background Division algorithm, Prime & Composite number, Euclidean algorithm, Extended Euclidean algorithm, congruences, Divisibility test, Chinese Remainder theorem, Wilson's theorem, Fermat's little Theorem, Euler's Theorem, Primality tests, primitive roots for primes, Integer factorization problem, Computing square roots in Zn	**10**
Module – III: Secrecy & Authentication **Secrecy:** DES, AES, IDEA, Diffie-Hellman Key exchange, RSA, Elliptic Curve Cryptography, ElGamal **Authentication:** Hash functions, Message Authentication Codes, MD5, SHA-512, Passwords, Authentication Tokens, Certificate Based Authentication, Biometric Authentication.	**10**
Module – IV: Threshold Cryptosystem & Digital Certificate **Threshold Cryptosystem:** Threshold Cryptography, Secret-Sharing Schemes, Multiparty Computation, Threshold Signature, Shamir's secret sharing, Secret resharing, Side-channel and fault attacks. **Digital Certificate:** Digital Certificate, Private Key Management, PKIX Model, Distributed key generation, Key Distribution Center (KDC).	**7**
Module – V: Real World Approaches IBM Secret key management protocol, ISDN, Kerberos, KryptoKnight, Privacy enhanced mail (PEM), Message security protocol (MSP), PGP, Public-Key Cryptography Standards (PKCS), Lightweight cryptography, Cryptocurrencies, Quantum computing, Broadcast encryption.	**7**

TEXTBOOKS:

1. Bruce Schneier and Neils Ferguson, "Practical Cryptography", First Edition, Wiley Dream tech India Pvt Ltd, 2003.

REFERENCE BOOKS:

1. J. H. Silverman, A Friendly Introduction to Number Theory, 4th Ed. Boston: Pearson, 2019 (ISBN No.: 978 9353433079, 935343307X
2. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security: Private Communications in a Public World", Prentice Hall of India, Second Edition, 2016. (UNIT V).
3. Douglas R Stinson and Maura B. Paterson, "Cryptography – Theory and practice", Fourth Edition, CRC Press,2018 (UNIT -I)
4. William Stallings, Cryptography and Network Security, Seventh Edition, Pearson Education, 2017. (UNIT I, II, III, IV)

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS534
Course title: INTERNET OF THINGS
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	Understand the basic concept and the IoT Paradigm.
2.	Grasp the state of art architecture for IoT applications.
3.	Learn the available protocols used for IoT.
4.	Design basic IoT Applications.
5.	Evaluate optimal IoT applications.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Identify the IoT Components and its capabilities.
CO2	Explain the architectural view of IoT under real world constraints.
CO3	Analyse the different Network and link layer protocols.
CO4	Evaluate and choose among the transport layer protocols.
CO5	Design an IoT application.

SYLLABUS

Module 1: Introduction to IOT [8L]

The definition of the Internet of Things, main assumptions and perspectives. Platform for IoT devices Device architectures. M2M Architectures, IoT reference Model - IoT Reference Architecture.

Module 2: Technology Fundamentals and Architecture of IOT [8L]

Node structure: Sensing, Processing, Communication, Topologies, Layer/Stack architecture. CoRE, REST Principles.

Wireless communication technologies. Wireless sensor networks, IPv6, 6LowPAN, Physical layer, network layer protocols, Routing protocols.

Module 3: Communication Technologies [8L]

Introduction to ZigBee, BLE, Wi-Fi, LTE, IEEE 802.11ah, Service oriented protocols (COAP), Service discovery protocols.

Communication protocols based on the exchange of messages (MQTT).

Module 4: Data processing for IoT [8L]

Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management. The Organization of data processing for the Internet of things. Cloud computing.

Module 5: Service Layer Protocols & Security [8L]

Service Layer -oneM2M, ETSI M2M Security in IoT Protocols –IPSec, DTLS

Application case studies: Smart Parking. Home Automation. Smart City.

Text Books:

1. Holler Jan, TsiatsisVlasios, Mulligan Catherine, Avesand Stefan, Karnouskos Stamatis, Boyle David, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, 2014.
2. Raj Pethuru and Raman Anupama C., The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press.
3. Madisetti Vijay and BahgaArshdeep, Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2014.
4. Vermesan Dr. Ovidiu, Friess Dr. Peter, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium	high	high	low	medium
CO2	medium	medium	high	medium	medium	high
CO3	high	high	high	high	medium	high
CO4	high	high	high	low	medium	high
CO5	high	high	high	medium	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

Specialization 1

COURSE INFORMATION SHEET
Course code: CS630
Course title: MODERN OPTIMIZATION TECHNIQUES
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	Model a problem of real world into a mathematical system.
2.	Recognize common issues that occur while modelling a real-life problem using optimization techniques.
3.	Understand the core concept of various Programming models.
4.	Select most suitable technique among the multiple option to solve a problem.
5.	Develop the capacity of suggesting changes to an existing system for optimal productivity.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Develop an understanding of optimization principles and their use in real-world problems.
CO2	Utilize optimization approaches to represent real-world challenges quantitatively.
CO3	Analytically identify, structure, and solve operational problems utilizing optimization methods.
CO4	Use meta heuristics like Tabu search and Swarm intelligence to obtain a global optimum solution.
CO5	Apply optimization methods in various domains to solve real-life problems.

SYLLABUS

Module 1: Linear Programming [8L]

Introduction to Linear Programming, Solving Linear Programming Problems, The Simplex Method, Duality Theory and Sensitivity Analysis, Other Algorithms for Linear Programming.

Module 2: Integer Programming [8L]

Some Formulation Examples, The Branch-and-Bound Technique for BIP and Mixed Integer Programming, The Branch-and-Cut Approach, The Incorporation of Constraint Programming.

Module 3: Nonlinear Programming [8L]

Sample Applications, Graphical Illustrations of Nonlinear Programming, One-Variable and Multi variable Unconstrained Optimization, The Karush-Kuhn-Tucker (KKT) Conditions, Quadratic Programming Separable Programming Convex and non-convex.

Module 4: Meta-heuristics [8L]

The Nature of Meta-heuristics, Simulated Annealing, Tabu Search, Iterated local search, Variable Neighborhood Search, and GRASP, Population-based approaches, Swam-Intelligence.

Module 5: Forecasting [8L]

Forecasting Models, Judgemental Forecasting methods, Time Series Forecasting Methods, Forecasting for Causal Series, Forecasting Errors.

Text Books:

1. Frederick S. Hillier and Gerald J. Lieberman, “Introduction to Operation Research”, 10th Edition, McGraw-Hill Education, 2015.

Reference Books:

1. Taha, Hamdy A., “Operations Research an Introduction”. 9th Edition, Pearson Prentice Hall, 2014.
2. Pradeep Prabhakar Pai, “Operations Research Principles and Practice”, Oxford Higher Education, 2012.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	medium	high	medium	low	high
CO2	high	high	medium	medium	medium	medium
CO3	high	high	medium	high	high	high
CO4	high	medium	medium	medium	medium	medium
CO5	high	medium	low	medium	high	medium

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS631
Course title: DEEP LEARNING
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	Understand the concept and architecture of deep learning, gradient descent and its variants
2.	Understand to concept of different types of attributes and their pre-processing.
3.	Understand the concept and architecture of Convolution Neural Networks.
4.	Understand the idea of Recurrent Neural Networks and backpropagation through time.
5.	Understand the architecture of LSTM, and GRU, RNN model

Course Outcomes

After the completion of this course, students are expected to:

CO1	Build deep learning model and apply optimization techniques
CO2	Implement numerical representation of data and its transformation.
CO3	Apply CNN with hyper parameters tuning.
CO4	Build RNN based Deep learning models.
CO5	Apply RNN to sequential data tasks.

SYLLABUS

Module 1: Introduction [8L]

Defining Deep Learning, Common Architectural Principles, Building blocks of Deep Learning, Understanding Bias and Variance, Hyperparameters, Gradient Descent and its Variants including Minibatch, Momentum, RMSProp, ADAM and Nesterov factor.

Module 2: Design Techniques for DL [8L]

Vectorization, Types of attributes – Nominal, Ordinal, Interval and Ratio, Feature Engineering and Normalization techniques, Dimensionality Reduction, One Hot Encoding, Data Augmentation

Module 3: Convolutional Neural Networks [8L]

Understanding images and CNNs, Basic architecture, Filters, Pooling and Stride. Configuring CNN Layers, Applying CNNs to common datasets. Challenges in working with CNNs

Module 4: Recurrent Neural Networks-I [8L]

Input Data and input layers, RNNs – basic architecture and backpropagation through time, Issues with RNNs – the vanishing and exploding gradient problem,

Module 5: Recurrent Neural Networks-II [8L]

LSTM – architecture and improvements over RNNs, GRUs. Applying Recurrent Neural Networks on common datasets, RNNs for NLP.

Text Books:

1. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner’s Approach”, O’Reilly Media, 2017
2. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." MIT Press book, 2015.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	medium	high	medium	medium	medium
CO2	medium	medium	medium	medium	medium	medium
CO3	high	high	high	high	high	high
CO4	high	high	high	high	high	high
CO5	high	high	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS632
Course title: DATA ANALYSIS AND INTERPRETATION
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	Develop a strong foundation in statistical analysis, probability distributions, and hypothesis testing methods.
2.	Explore and apply machine learning algorithms for regression and classification problems.
3.	Analyze and optimize machine learning models for performance enhancement.
4.	Understand and implement unsupervised learning techniques addressing challenges in big data analytics.
5.	Applying prescriptive analytics techniques for data-driven decision-making.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Develop a strong foundation in descriptive and inferential statistics.
CO2	Learn and implement regression models.
CO3	Learn and implement supervised learning models.
CO4	Learn the different methods of combining classifiers.
CO5	Learn and implement unsupervised learning models.

SYLLABUS

Module 1: Descriptive Statistics [10L]

Introduction to the course Descriptive Statistics Probability Distributions Inferential Statistics-Inferential Statistics through hypothesis tests Permutation & Randomization Test.

Module 2: Machine Learning [8L]

Introduction and Concepts Differentiating algorithmic and model based frameworks Regression: Regression & ANOVA Regression ANOVA (Analysis of Variance) Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification.

Module 3: Supervised Learning with Regression and Classification techniques [8L]

Bias-Variance Dichotomy, Model Validation Approaches, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Regression and Classification Trees, Support Vector Machines.

Module 4: Ensemble Methods [6L]

Random Forest, Neural Networks, Deep learning.

Module 5: Unsupervised Learning and Challenges for Big Data Analytics [8L]

K-Means and Hierarchical Clustering, Associative Rule Mining, Challenges for big data analytics. Prescriptive analytics- Creating data for analytics through designed experiments, Creating data for analytics through Active learning, Creating data for analytics through Reinforcement learning.

.

Text Books:

1. Hastie, Trevor, Tibshirani, Robert, Friedman, Jerome, "The Elements of Statistical Learning". Vol. 2. No. 1. Springer, New York, 2009.
2. Montgomery, Douglas C., and Runger George C., "Applied statistics and probability for Engineers". John Wiley & Sons, 2010.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium	medium	high	low	medium
CO2	high	medium	high	high	high	medium
CO3	high	medium	high	high	high	high
CO4	medium	medium	medium	high	high	high
CO5	high	medium	high	medium	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS633
Course title: NATURAL LANGUAGE PROCESSING
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	1	0	4

Course Outcomes

After the completion of this course, students are expected to:

CO1	Describe the typical NLP problem, their importance & difficulty; and concepts of orphology, syntax, semantics, discourse & pragmatics of natural language.
CO2	Demonstrate understanding of the relationship between NLP and statistics& achine learning.
CO3	Discover various linguistic and statistical features relevant to the basic NLP task, amely, spelling correction, morphological analysis, parts-of-speech tagging, parsing nd semantic analysis.
CO4	Analyse NLP problems to decompose them into appropriate components.
CO5	Evaluate a NLP system, identify shortcomings and suggest solutions for these hortcomings.

SYLLABUS

Module 1: Introduction to NLP [8L]

NLP – introduction and applications; NLP phases; Difficulty of NLP including ambiguity; Regular Expression; Words and Corpora; Basics of Tokenization, Normalization, Lemmatization and Stemming. Case Study: Learn certain preprocessing techniques using an NLP toolkit.

Module 2: N-gram Language Model [8L]

N-gram; Simple Bi-gram models; Evaluating language models; Issues of Unknown word; Smoothing (basic techniques); Neural Language Model.
Case study: An application of N-gram language model.

Module 3: Vector Semantic and Embedding [8L]

Lexical Semantics: basic concepts; Vector Semantics; Words and Vectors; Concepts of Cosine Similarity, TF-IDF, PMI; Word2Vec; Semantic Properties of Embedding. Case Study: Study on Word2Vec model and relation between various words.

Module 4: Sequence Labelling: Parts-of-speech Tagging [8L]

Parts-of-speech Tagging: basic concepts; Word Classes and Tagset; POS tagging using Hidden Markov Model; Working with a toy example; Concept of Named Entity Recognition.
Case Study: POS tagging in Indian languages.

Module 5: Parsing [8L]

Basic concepts: Context Free Grammar and English Grammar Rules; Top down and bottom-up parsing, treebank; Syntactic parsing; working of CKY parsing.
Case Study: Application of Parsing in a text processing task.

Text Books:

1. Dan Jurafsky and James H. Martin. Speech and Language Processing **(3rd ed.)** *To be published*. Available at: https://web.stanford.edu/~jurafsky/slp3/.

Reference Books:

1. D. Jurafsky and J. H. Martin. Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Second Edition, Upper Saddle River, NJ: Prentice-Hall, 2008.
2. Steven Bird, Ewan Klein, and Edward Loper. Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit. O'Reilly. (Latest version)

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	medium	high	medium	low	high
CO2	medium	high	medium	medium	medium	medium
CO3	medium	high	medium	high	high	high
CO4	high	medium	medium	medium	medium	medium
CO5	medium	medium	low	medium	high	medium

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS635
Course title: REINFORCEMENT LEARNING
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Outcomes

After the completion of this course, students are expected to:

CO1	Explain with examples the basic concepts of reinforcement learning
CO2	Solve problems of MDP and DP
CO3	Explain the implementation of different MC and TD Algorithms
CO4	Demonstrate bootstrapping, planning and learning models.
CO5	Elaborate the functions of on and off policy prediction with approximation.

SYLLABUS

Module 1 [8L]

Introduction, Reinforcement Learning, Elements of Reinforcement Learning, Limitations, Examples of Reinforcement learning, Early History of Reinforcement Learning, Introduction to Tabular Search Method with examples. A k-armed Bandit Problem, Action-value Methods, The 10-armed Testbed, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandit Algorithms, Associative Search (Contextual Bandits).

Module 2 [8L]

Finite Markov Decision Processes, The Agent–Environment Interface, Goals and Rewards, Returns and Episodes, Unified Notation for Episodic and Continuing Tasks, Policies and Value Functions, Optimal Policies and Optimal Value Functions, Optimality and Approximation.

Module 3 [8L]

Dynamic Programming, Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming.

Module 4 [8L]

Monte Carlo Methods, Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-policy Monte Carlo Control.

Module 5 [8L]

Temporal-Difference Learning, TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), Sarsa: On-policy TD Control, Q-learning: Off-policy TD Control, Expected Sarsa, Maximization Bias and Double Learning, Games, Afterstates, and Other Special Cases

Text Books:

Sutton R.S., Barto A. G., Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2018.
Belousov B., Abdulsamad H., Klink P., Parisi S., Peters J., "Reinforcement Learning Algorithms: Analysis and Applications", Springer Publications, 2021.

Reference Books:

Graesser L., Keng, W. L., "Foundations of Deep Reinforcement Learning: Theory and Practice in Python", 1st Edition, Addison Wesly Press, 2020.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	high	high	medium	medium	medium
CO2	high	high	medium	medium	high	low
CO3	high	high	medium	high	medium	medium
CO4	high	high	high	high	medium	low
CO5	high	high	high	high	low	low

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS636
Course title: EVOLUTIONARY COMPUTING
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	Understand the principles of evolutionary computing.
2.	Familiarize with the mathematical aspect of evolutionary computing.
3.	Analyze how evolutionary computing is used to solve problems.
4.	Develop an understanding of multi-objective evolutionary optimization models.
5.	Apply the use of evolutionary computing for machine learning and the implementation aspects.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Differentiate and understand various evolutionary computation techniques.
CO2	Grasp the fundamental of genetic algorithms.
CO3	Apply advance techniques for multi-objective optimization.
CO4	Explore different methods for multi-objective evolutionary optimization.
CO5	Design of Genetic Algorithm based applications in Machine Learning.

SYLLABUS

Module 1: Introduction to Evolutionary Computation [8L]

Generic Evolutionary Algorithm, Representation – The Chromosome, Initial Population, Fitness Function, Selection, Reproduction Operators, Stopping Conditions, Evolutionary Computation versus Classical Optimization.

Module 2: Genetic Algorithms [8L]

Canonical Genetic Algorithm, Crossover, Mutation, Control Parameters, Genetic Algorithm Variants: Generation Gap Methods, Messy Genetic Algorithms, Interactive Evolution, Island Genetic Algorithms.

Module 3: Advanced Topics [8L]

Niching Genetic Algorithms, Constraint Handling, Multi-Objective Optimization, Dynamic Environments, Applications, Coevolution: Competitive Fitness, Generic Competitive Coevolutionary Algorithm

Module 4: Multi-objective Evolutionary Optimization [8L]

Multi-objective Problems: Linear, Nonlinear, Convex, Nonconvex; Pareto optimality, Multi- objective Optimization, Methods: Weighted Sum Method, e-Constraint Method, Weighted Matrix Method, Benson's Method, Value Function Method, Goal Programming Method.

Module 5: Application of Genetic Based Machine Learning (GBML) [8L]

Rise of GBML, Development of CS-1, Smith's Poker Player, Other efforts of GBML, Current Applications of GBML: BOOLE, CL-ONE, Simple sequential Programs: JB and TB.

Text Books:

1. A. P. Engelbrecht, Computational Intelligence, Wiley, USA, 2007.
Genetic Algorithms in Search, Optimuization and machine Learning, D. E. Goldberg, Addition -Wisley Companay Inc, 1989.
2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley, USA,2001.

Reference Books:

1. S.N.Sivanandam & S.N.Deepa, Introduction to Genetic Algorithms, Springer Berlin Heidelberg New York, 2008.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	medium	high	medium	low	high
CO2	medium	high	medium	medium	medium	medium
CO3	medium	high	medium	high	high	high
CO4	high	medium	medium	medium	medium	medium
CO5	medium	medium	low	medium	high	medium

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS637
Course title: COMPUTATIONAL NETWORK ANALYSIS
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students:

1.	To understand the principles of Evolutionary Computing
2.	To familiarize with the mathematical aspects of Evolutionary Computing
3.	To analyze how Evolutionary Computing could be used to solve problems.
4.	To develop Multi-objective Evolutionary Optimization and their implementation
5.	To apply the use of Evolutionary Computing for Machine Learning and their implementational aspects

Course Outcomes

After the completion of this course, students are expected to:

CO1	Differentiate and understand various evolutionary computation techniques
CO2	Identify algorithms suitable for solving certain evolutionary computation problems.
CO3	Apply evolutionary computation techniques to optimization, learning, and design.
CO4	Implement GA based systems for different applications and multi-objective problems.
CO5	Design of Genetic Algorithm based applications in Machine Learning

SYLLABUS

Module 1: Origins and Related Graph Theory [8L]

What is network science? General Principles. Set theoretic definition of a graph. Matrix algebra definition of a graph. The Konigsberg Graph. Spectral properties of graphs. Types of graphs. Topological structures.

Module 2: Regular Networks [8L]

Defining regular networks, Network Characteristics - Diameter, Centrality, and Average Path Length, Binary Tree Network, Toroidal Network, Hypercube Networks,

Module 3: Random Networks [8L]

Generation of Random Networks, Degree Distribution of Random Networks, Entropy of Random Networks, Properties of Random Networks, Weak Ties in Random Networks, Randomization of Regular Networks, Analysis.

Module 4: Small World Networks [8L]

Generating a Small-World Network, Properties of Small-World Networks, Phase Transition, Navigating Small Worlds, Weak Ties in Small-World Networks, Analysis.

Module 5: Scale Free Networks [8L]

Generating a Scale-Free Network, Properties of Scale-Free Networks, Navigation in Scale- Free Networks, Analysis.

Text Books:

1. Lewis, T. G., Network Science: Theory & Practice, 1st Edition, John Wiley & Sons. Inc. Publications, 2009.

Reference Books:

2. Newman M., Networks: An Introduction, 1st Edition, Oxford University Press, 2010.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	medium	high	medium	low	high
CO2	medium	high	medium	medium	medium	medium
CO3	medium	high	medium	high	high	high
CO4	high	medium	medium	medium	medium	medium
CO5	medium	medium	low	medium	medium	medium

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

Specialization 2

COURSE INFORMATION SHEET
Course code: CS660
Course title: Content Based Image and Video Retrieval

Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objectives

This course enables the students to:

1.	To understand the modules involved in designing CBIVR systems and their applications
2.	To Extract different visual features from images and videos
3.	To Understand query specification and evaluate the retrieval.
4.	To Understand indexing and the semantics of visual data
5.	To Develop and evaluate visual retrieval algorithms

Course Outcomes

After the completion of this course, students are expected to:

CO1	Able to apply the techniques for designing CBIVR problems
CO2	Able to apply different feature extractions techniques
CO3	Able to measure color, texture, shape and spatial relationship
CO4	Able to index the Query Languages and apply in search
CO5	Able to use different retrieval applications and its semantics

Syllabus:

Module-I: Architecture and Design: Introduction
Architecture of content-based image and video retrieval – Designing an image retrieval system – Designing a

video retrieval system.

Module-II Feature extraction and similarity measure
Color – Texture – Shape – Spatial relationships – MPEG 7 features. Video Indexing and understanding- Query Language for multimedia search- Relevance feedback- Semantic based retrieval – Trademark image retrieval- Standards relevant to Content based image retrieval- Query Specification – Metadata description.

Module-III Content based Image Retrieval
Color based Retrieval, Texture based Retrieval, Content Based Retrieval, Information based Retrieval

Module-IV Content based video Retrieval
Feature extraction – Semantics understanding -Summarization – Indexing and retrieval of video, Case studies and applications.

Module-V Storage and System Architecture
Storage Architectures for Digital Imagery, Database Support for Multimedia Applications, Image Compression, Transmission of Digital Imagery

Textbooks / References

1. Oge Marques and Borko Furht, "Content Based Image and Video Retrieval", Multimedia Systems and Applications, Springer, 2002, Kluwer Academic Publisher.
2. Lew, Michael S, "Principles of Visual Information Retrieval", Advances in Pattern recognition, Springer, 2001.
3. Image Databases: Search and Retrieval of Digital Imagery , by Vittorio Castelli and Lawrence D. Bergman, Wiley-Inter science, 2001.

Reference Book:
'Content Based Image and Video Retrieval' is an elective course offered in M. Tech., in Computer Science and Engineering program at School of Engineering, Amrita Vishwa Vidyapeetham.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET

Course code: CS661

Course title: **Machine Learning for Machine Vision**
Pre-requisite(s): CS327 Computer Graphics
Co- requisite(s):
Credits: L:3 T:1 P:0
Class schedule per week: 4
Class: B.Tech
Semester / Level: IV
Branch: B Tech/IT

Course Objectives

This course enables the students:

1.	Be familiar with both the theoretical and practical aspects of computing with images.
2.	Have described the foundation of image formation, measurement, and analysis.
3.	Understand the geometric relationships between 2D images and the 3D world.
4.	Grasp the principles of state-of-the-art deep neural networks

Course Outcomes

After the completion of this course, students will be able to:

1.	Developed the practical skills necessary to build computer vision applications.
2.	To have gained exposure to object and scene recognition and categorization from images.
3.	Develop algorithm for classification and clustering.
4.	Illustrate the techniques of different models for vision
5.	Apply in different engineering application such Image retrieval, Object detection, etc.

Syllabus

Module 1: Understanding machine learning basics: [8 Lectures]

Probability basics: probability, common probability distributions, probability models, normal distributions, Neural Network: Perceptron, Activation functions, Artificial neural network (ANN), CNN. Machine learning for machine vision: learning and inference in vision, modelling complex data densities, regression, and classification models

Module 2: Models for Geometry [8 Lectures]

Pinhole camera, Models for transformations, Multiple cameras, Predictive Models, Descriptive Models, training a Model, Model Representation and Interpretability, Evaluating Performance of a Model

Module 3: Models For Vision [8 Lectures]

Models for shape, style and identity, temporal models, and models for visual words, Generative Models

Module 4: Models for Image Retrieval [8 Lectures]

Understanding visual features, Visualizing activation of deep learning models, Embedding visualization, Model Inference, Content based image retrieval, Autoencoders.

Module 5: Models for Object Detection [8 Lectures]

Object Detection**,** Detecting objects in an image, Exploring the datasets, ImageNet dataset, PASCAL VOC challenge, COCO object detection challenge, Localizing algorithms , Detecting objects, The YOLO object detection algorithm.

Text Book

1. Deep Learning for Computer Vision, by Rajalingappaa Shanmugamani, Released January 2018, Publisher(s): Packt Publishing, ISBN: 9781788295628
2. Computer Vision: Models, Learning and Interface, Simon J.D Prince, Cambridge University Press, 2012

Reference Book:

1. Computer Vision a Modern Approach by David a Forsyth. Pearson Education, Second Edition 2015
2. Machine Learning by S Dutt, S Chandramouli, A.K.Das, Pearson, First Publication 2019
3. Neural Networks and Learning Machine by Simon Haking, Pearson and Prentice Hall, 2009

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS662
Course title: COMPUTER VISION

Pre-requisite(s): Linear Algebra, Vector Calculus, Data Structure & Programming

L	T	P	C
3	0	0	3

Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/5
Branch: CSE

Course Objectives

This course enables the students to:

1.	***To understand*** *both the theoretical and practical aspects of computing with images.*
2.	***To describe*** *the foundation of image formation, measurement, and analysis.*
3.	***To Understand*** *the geometric relationships between 2D images and the 3D world.*
4.	***To Apply*** *the principles of state-of-the-art technologies in Vision Problems*
5.	***To understand*** *both the theoretical and practical aspects of computing with images.*

Course Outcomes

After the completion of this course, students will be able to:

CO1	**Develop** skills to build computer vision-based applications.
CO2	**Expose** to object and scene recognition and categorization from images.
CO3	**Develop** algorithm for Model fitting and Recognition.
CO4	**Apply** techniques of feature detection and matching.
CO5	**Apply** in different industry applications such activity recognition, computational photography, biometrics, Feature Detection, Model Fitting, Depth Estimation

SYLLABUS

Module I: (8H)
Introduction to Computer Vision
Computer Vision – what and why? Image Formation, Digital Camera, Linear and Non Linear Filtering, Fourier and Geometric Transforms, Pyramid and Wavelets.

Module II: (8H)
Model Fitting and Recognition
Scattered data interpolation, Variational methods and regularization, Instance Recognition, Image Classification, Object Detection, Semantic Segmentation, Video Understanding, Vision Language.

Module III: (8H)
Feature Detection and Matching
Points and Patches, Edge and Contours, Contour Tracking, Lines and Vanishing point Segmentation.

Module IV: (8H)
Image alignment, Stitching and Motion Estimation
Pairwise, Global and Translational alignment, Image Stitching, Compositing, Parametric, Optical, Layered Motion

Module V: (8H)
Depth Estimation and 3D construction
Epi polar Geometry, Sparse and Dense Correspondence, Deep networks, Monocular depth estimation, 3D scanning, Point, Surface, Volumetric Representations,

Books recommended:
TEXT BOOK

1. Computer Vision: Algorithms and Applications by Richard Szeliski , Second Edition, Springer, 2021

REFERENCE BOOK

1. Deep Learning, by Goodfellow, Bengio, and Courville., 2018
2. Dictionary of Computer Vision and Image Processing, by Fisher et al., 2015
3. Computer Vision A Modern Approach David A forsyth etc. Pearson Education Second Indian Reprint 2015

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET

Course code: CS664

Course title: **GPU Computing**
Pre-requisite(s): Operating System
Co- requisite(s): None
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03

Course Objectives
This course enables the students to:

1.	Identify the different kinds of parallel models used in computing
2.	Identify common programming constructs used in parallel programming.
3.	Understand the basic hardware of GP-GPUs.
4.	Visualize the concepts of grids, blocks and threads in GPU computing.
	Understand the different memory types available in GPU programming.

Course Outcomes
After the completion of this course, students will be able to:

1.	Identify the various components that go into the making of GPUs.
2.	Describe the computer capabilities of a GPU based system.
3.	Formulate logic in multiple dimensions to solve problems using GPUs.
4.	Utilize the various memory modules available in GPU.
5.	Measure the gain in performance between CPUs and GPUs.

Syllabus
Module I: A Short History of Supercomputing [8L]
Introduction, Von Neumann Architecture, CrayConnection Machine, Cell Processor, Multinode Computing, The Early Days of GPGPU Coding, The Death of the Single-Core Solution, NVIDIA and

CUDAGPU Hardware, Alternatives to CUDA,:OpenCL,DirectCompute,CPU alternatives, Directives and libraries.

Module II: Understanding Parallelism with GPUs [8L]

Introduction, Traditional Serial Code, Serial/Parallel Problems, Concurrency, Locality, Types of Parallelism, Task-based parallelism, Data-based parallelism, Flynn's Taxonomy, Some Common Parallel Patterns, Loop-based patterns, Fork/joinpattern, Tiling/grids, Divide and conquer.

Module III: CUDA Hardware

Overview, PC Architecture, GPU Hardware, CPUs and GPUsCompute Levels, Characteristics of different compute levels.

Module IV: Grids, Blocks, and Threads [8L]

What it all Means, Threads, Problemdecomposition, How CPUs and GPUs are different, Task execution model, Threading on GPUs, A peek at hardware, CUDA kernels, Blocks, Block arrangement, Grids, Stride and offset, X and Y thread indexes, Warps, Branching, GPUutilization, Block Scheduling.

Module V: Memory Handling with CUDA [8L]

Introduction, Caches, Types of data storage, RegisterUsage, Shared Memory, Sorting using shared memory, Radix sort, Merging lists, Parallel merging, Parallelreduction, A hybridapproach, Shared memory on different GPUs, Shared, Constant Memory, Constant memorycaching, Constant memory broadcast, Constant memory updates at runtime, Global Memory, Scoreboarding, Global memory sorting, Sample sort, Texture Memory, Texture caching, Hardware manipulation of memory fetches.

Text Book:

Cook S., "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs," First Edition, Morgan Kauffman, 2013.(T1)

Reference Books:

Kirk W. B., Hwu W. W., "Programming Massively Parallel Processors", Second Edition, Morgan Kauffman, 2013.(R1)

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET

Course code: CS666
Course title: **Data Compression**
Pre-requisite(s): Image Processing, Big Data, ICT
Co- requisite(s): None
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03

Course Objectives
This course enables the students to:

1.	Introduce basic applications, concepts, and techniques of Data Compression
2.	Familiar with the concepts of using data compression software to solve practical problems in a variety of disciplines.
3.	To gain experience doing independent study and research.

Course Outcomes
After the completion of this course, students will be able to:

1.	Understand the techniques of data compression
2.	Develop a reasonably sophisticated data compression application
3.	Apply methods and techniques appropriately with respect to the nature of the Data
4.	Develop methods and tools for the Data Compression task
5.	Develop algorithms using Models

Syllabus

Module I: Introduction: Compression Techniques [3L]

Modeling and Coding Mathematical Preliminaries for Lossless Compression: Models – Physical Models, Probability Models, Markov Models Coding – Uniquely Decodable Codes, Prefix codes

Module II: Huffman Coding [10L]

Huffman coding: The Huffman Coding Algorithm – Minimum variance Huffman codes Adaptive Huffman coding – Update Procedure, Encoding Procedure, Decoding Procedure Golomb Codes Rice codes Tunstall Codes Applications of Huffman Coding – Lossless Image compression, Text compression, Audio Compression Arithmetic coding: Coding a sequence – Generating a Tag, Deciphering the Tag Generating Binary Code – Uniqueness and Efficiency of the Arithmetic code, Algorithm implementation, Integer Implementation Comparison of Huffman and Arithmetic coding Applications,

Module III: Dictionary Techniques [7L]

Static Dictionary – Diagram Coding Adaptive Dictionary – The LZ77 approach, The LZ78 Approach, applications of Image Compression

Module IV: Context based Compression [8L]

Prediction with partial match(ppm) – The Basic Algorithm, The Escape symbol, Length of context, The Exclusion Principle The Burrows-Wheeler Transform – Move-to-Front Coding, Lossless Compression standards zip, gzip, bzip, unix compress, GIF, JBIG. Image & Video compression, Basis functions and transforms from an intuitive point, JPEG, MPEG,

Module V: Wavelet based Compression CUDA [12L]

Fundamentals of wavelets, Various standard wavelet bases, Multi resolution analysis and scaling function, JPEG 2000I, Mathematical Preliminaries for Lossy Coding: Distortion criteria – The Human Visual System, Auditory Perception Models – Probability Models, Linear System Models, Physical Models Scalar Quantization: The Quantization Problem Uniform Quantizer Adaptive Quantization – Forward Adaptive , Backward Adaptive Non uniform Quantization – pdf optimized Quantization, Companded Quantization Entropy Coded Quantization – Entropy coding of Lloyd – Max Quantizer Outputs Vector Quantization : Advantages of Vector Quantization over Scalar Quantization The Linde-Buzo-Gray Algorithm Tree structured Vector Quantization Structured Vector Quantization

Text & Reference Books:

1)Introduction to Data Compression –By Khalid Sayood, Third Edition, publication Elsevier
2) The Data Compression book, By Mark Nelson,Jean Loup Gaily
3) Data Compression : The Complete Reference", By David Saloman, publication Springer
4) Data Compression Methods and Theory - by James A. Storer

Mapping of Course Outcomes onto Program Outcomes

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET

Course code: CS667
Course title: Signal Processing Algorithms
Pre-requisite(s): Design Analysis of Algorithms, Digital Image Processing
Co- requisite(s):
Credits: L:3 T:0 P: 0
Class schedule per week: 3
Class: M. Tech
Semester / Level: 1st/ Vth
Branch: AI/ML

Course Outcomes

After the completion of this course, students will be:

1	To apply the basic concepts and tools for modelling and analysing signals.
2	To explain advanced statistical tools and numerical methods to describe the temporal dynamics of signals.
3	To apply how to evaluate data-driven predictive models.
4	To formulate engineering problems in terms of DSP tasks.
5	To Analyse digital and analogy signals and systems

SYLLABUS

Module-I [6L]
Orthogonal transforms: DFT, DCT and Haar; Properties of DFT; Computation of DFT: FFT and structures, Decimation in time, Decimation in frequency; Linear convolution using DFT.
Module-II [8L]
Digital filter structures: Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel all pass realization of IIR transfer functions, Sine- cosine generator; Computational complexity of filter structures; Mult irate signal processing: Basic structures for sampling rate conversion
Module-III [10L]
Decimators and Interpolators; Multistage design of interpolators and decimators; Polyphase decomposition and FIR structures; Computationally efficient sampling rate converters; Arbitrary sampling rate converters based on interpolation algorithms: Lagrange interpolation, Spline interpolation.
Module-IV [9L]
Quadrature mirror filter banks; Conditions for perfect reconstruction; Applications in sub band coding, Digital Signal Processors introduction: Computational characteristics of DSP algorithms and applications; Techniques for enhancing computational throughput: Harvard architecture, parallelism, pipelining, dedicated multiplier, split ALU and barrel shifter.
Module-V- [7L]
TMS320C64xx architecture: CPU data paths and control, general purpose register files, register file cross paths, memory load and store paths, data address paths, parallel operations, resource constraints.

Textbook:

1. R. Chassaing and D. Reay, *Digital signal processing and applications with TMS320C6713 and TMS320C6416*, Wiley, 2008.
2. S. K. Mitra, *Digital Signal Processing: A Computer Based Approach*, 3rd Edn., TMH, 2008.
3. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing:*
4. Principles, Algorithms and Applications, Pearson Prentice Hall, 2007

References Book:

1. H. L. Van Trees, Detection, Estimation and Modulation Theory, Part I, John Wiley, 1968.
2. H. V. Poor, An Introduction to Signal Detection and Estimation, 2nd edition, Springer, 1994.
3. S. J. Orfanidis, Optimum Signal Processing, 2nd Edition, 2007 republication of the 1988 McGraw-Hill edition.

Mapping of CO-PO

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET
Course code: CS668
Course title: Digital Video Processing
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/5
Branch: CSE

L	T	P	C
3	0	0	3

Course Objective:
The course enables student to

1. To Understand principles of digital image and video formation, sampling, and quantization
2. Apply spatial and frequency domain filtering for image enhancement and restoration.
3. Explore morphological operations and segmentation methods for feature extraction.
4. Learn motion estimation techniques including optical flow and block matching.
5. Understand video representation models and their applications in coding and streaming.

Course Outcome:

After the completion of this course, students will be able to:

1. Describe Core Concepts
2. Apply Enhancement Techniques
3. Perform Segmentation and Motion Estimation
4. Utilize Color Models and Transformations
5. Design and implement video processing solutions for applications

Syllabus

Module-I Introduction [8L]
Video Sampling and Interpolation, Basic Linear Filtering with Applications to Image Enhancement, Computational Models of Early Human Vision, Motion Detection and Estimation, Optical Flow Methods, Motion Compensated Filtering

Module-II Video Enhancement and Restoration [8L]
Process of Video Enhancement and Restoration, Video Quality Assessment, Restoration, Super-resolution, Video Segmentation, Motion Segmentation

Module-III Tracking [8L]
Motion Tracking in Video, 2D and 3D Motion Tracking in Digital Video, Methods using Point Correspondences, Optical Flow and Direct Methods, Optimization, Pel-Recursive Methods, Bayesian Methods

Module-IV Video Coding Standards [8L]
MPEG-1,2,4, H264, Digital Video Transcoding, Embedded video codecs, Video Quality assessment

Module-V Applications [8L]
Video Stabilization and Mosaicing, A Unified Framework for Video Indexing, Summarization, Browsing and Retrieval, Video Surveillance

Textbooks

1. The Essential Guide to Video Processing Al Bovik (Alan C Bovik), Academic Press, Second Edition, 2009

2. Handbook of Image and Video processing - Al Bovik (Alan C Bovik), Academic Press, Second Edition, 2005.
3. Digital Video Processing - A. Murat Tekalp, Prentice Hall, 1995

References

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. IEEE-T-CSVT (IEEE Transactions on Circuit Systems and VIdeo Technology).

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

Specialization 3

COURSE INFORMATION SHEET

Course Code: CS670
Course Title: Biometric Security

Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3 L
Class: M. Tech.
Semester / Level: II/ II
Branch: CSE

COURSE OBJECTIVES

This course envisions to impart the students to:

1.	Understand the fundamentals and functioning of biometric systems.
2.	Explore different types of biometric modalities and evaluate their accuracy and reliability.
3.	Raise awareness about privacy and ethical considerations in biometric data usage.
4.	Promote the secure deployment of biometric technologies to protect personal and informational privacy.
5.	Enhance knowledge of techniques to strengthen security of systems and sensitive data.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Differentiate individuals accurately using biometric identification techniques.
CO2	Apply two-factor authentication systems in practical security scenarios.
CO3	Integrate concepts from biometric systems into advanced research and application development.
CO4	Design and evaluate advanced authentication algorithms using biometric principles.
CO5	Analyze how physiological and behavioral characteristics contribute to enhancing system security.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Biometric Fundamentals Introduction, why biometrics, How Authentication Technologies work, Benefits of biometrics over traditional authentication systems, How Biometrics work, Benefits of biometrics in identification systems, Selecting a biometric for a system, Applications, Key biometric terms and processes, how biometric matching works, Accuracy in biometric systems.	**10**
Module – II: Types of Biometrics Fingerprints and Hand Geometry: Technical description, Characteristics, Competing technologies, Strengths–Weaknesses, Deployment. Facial and Voice Recognition: Technical description, Characteristics, Strengths-Weaknesses, Deployment.	**7**
Module – III: Iris and Retina Scanning Technical description, Characteristics, Strengths – Weaknesses, Deployment. Retina vascular pattern. Signature Recognition and Keystroke Dynamics: Signature Recognition and keystroke Dynamics	**10**
Module – IV: Behavioral and Esoteric Biometric Technologies Vein Pattern, Facial Thermography, DNA, Body Oder, Ear, Footprint and Foot Dynamics	**7**
Module – V: Privacy, Policy and Legal Concerns Raised by Biometrics Biometrics and Privacy, Legal considerations of Government Use of Biometrics, Biometrics and the Feasibility of a National ID card, Case studies on Physiological, Behavioral and multifactor biometrics in identification systems.	**6**

TEXTBOOKS:

1. Bru John D. Woodward, Jr. Nicholas M. Orlans Peter T. Higgins, “Biometrics”, Dream tech, 2003.
2. Samir Nanavathi, Michel Thieme, Raj Nanavathi,” Biometrics -Identity verification in a network”, Wiley Eastern, 2002.

REFERENCE BOOKS:

1. John Chirillo and Scott Blaul,” Implementing Biometric Security”, Wiley Eastern Publications, 2005.
2. John Berger,” Biometrics for Network Security”, Prentice Hall, 2004.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Quiz 1	10
Quiz 2	10
Quiz 3	10
Seminar Presentation	10
Assignment/ Assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT
1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Mini projects/projects

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

Grading: No Correlation – 0, Low Correlation - 1, Moderate Correlation – 2, High Correlation - 3

Mapping Between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD4
CO5	CD1, CD4

COURSE INFORMATION SHEET

Course Code: CS671
Course Title: Biometric Security Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 4 L
Class: M. Tech.
Semester / Level: II/ II
Branch: CSE

COURSE OBJECTIVES

This course envisions to impart the students to:

1.	Understand the working principles of various biometric systems and their real-world applications.
2.	Implement biometric authentication techniques and evaluate their performance.
3.	Analyze privacy, security, and ethical issues in biometric applications.
4.	Apply biometric concepts in real-time projects and research scenarios.
5.	Explore advanced authentication techniques and methods to improve accuracy.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Implement biometric algorithms for fingerprint, face, iris, and voice recognition.
CO2	Evaluate biometric system performance using metrics such as accuracy, precision, recall, FAR, and FRR.
CO3	Integrate multi-factor authentication in security applications.
CO4	Apply biometric techniques in practical projects with privacy considerations.
CO5	Demonstrate knowledge of advanced biometric security techniques.

SYLLABUS

MODULE	(NO. OF SESSIONS)
Module – I: Biometric Fundamentals and System Setup Lab Problems: • Install and configure biometric software libraries (OpenCV, Python Biometric SDK). • Implement a simple image capture and preprocessing pipeline. • Test enrollment and verification for a sample biometric dataset.	**3**
Module – II: Fingerprint & Hand Geometry Recognition Lab Problems: • Extract minutiae points from fingerprint images. • Implement fingerprint matching using Euclidean/Minutiae-based algorithms. • Compare accuracy of fingerprint recognition with hand geometry.	**3**
Module – III: Iris & Retina Recognition Lab Problems: • Segment Iris region from an eye image using Daugman's algorithm. • Encode Iris features using Gabor filters and match with stored templates. • Compare iris recognition accuracy against retinal pattern recognition.	**3**
Module – IV: Face and Voice Recognition Lab Problems: • Implement face detection and recognition using Haar Cascade and LBPH in OpenCV. • Implement voice authentication using MFCC feature extraction. • Evaluate multi-modal authentication by combining face and voice recognition.	**3**
Module – V: Privacy, Security & Performance Evaluation Lab Problems: • Measure False Acceptance Rate (FAR) and False Rejection Rate (FRR) for biometric systems. • Implement multi-factor authentication (password + biometric). • Analyze a case study on privacy and security issues in biometric deployment.	**2**

TEXTBOOKS:

1. Bru John D. Woodward, Jr. Nicholas M. Orlans Peter T. Higgins, "Biometrics", Dream tech, 2003.
2. Samir Nanavathi, Michel Thieme, Raj Nanavathi," Biometrics -Identity verification in a network", Wiley Eastern, 2002.

REFERENCE BOOKS:

1. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley Eastern Publications, 2005.
2. John Berger," Biometrics for Network Security", Prentice Hall, 2004.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	% Distribution
Day to Day Performance	30
Quiz 1	10
Viva	20

Continuous Internal Assessment	% Distribution
End Sem Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Mini projects/projects

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

Grading: No Correlation – 0, Low Correlation - 1, Moderate Correlation – 2, High Correlation - 3

Mapping between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD4
CO5	CD1, CD4

COURSE INFORMATION SHEET

Course Code: CS672
Course Title: Cyber Security and Digital Forensics
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3 L
Class: M. Tech.
Semester / Level: II/ II
Branch: CSE

COURSE OBJECTIVES

This course envisions to impart the students to:

1.	Develop a comprehensive understanding of cyber security principles, threats, and safeguards.
2.	Acquire knowledge of digital forensics techniques for detection, investigation, and prevention of cybercrimes.
3.	Gain proficiency in Intrusion Detection and Prevention Systems to secure digital infrastructures.
4.	Apply techniques for evidence collection, preservation, and analysis of digital devices and networks
5.	Understand the legal, ethical, and professional considerations in cyber security and forensics.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Describe fundamental concepts of cyber security, types of cybercrimes, associated vulnerabilities, and applicable laws and ethical issues
CO2	Apply appropriate techniques to secure web applications, services, and servers using standard security practices and identity management.
CO3	Demonstrate knowledge of intrusion detection and prevention systems by implementing techniques and tools to detect and prevent malicious activities.
CO4	Analyze digital forensic processes, tools, and techniques for evidence collection, preservation, and investigation of cyber incidents.
CO5	Evaluate the suitability of forensic tools and procedures for handling audio-video evidence and conducting email investigations in a cybercrime context.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Introduction to Cyber Security and Cyber Crime Introduction to Cyber Security, Cyber Security Vulnerabilities and Cyber Security Safeguards Cyber Security Vulnerabilities – Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Unprotected Broadband communications, Cyber Security Safeguards – Overview, overview of cybercrime and its types.	**8**
Module – II: Securing Web Applications Securing Web Application, Services and Servers Introduction, Basic security for HTTP Applications and Services, Basic Security for SOAP Services, Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.	**8**
Module – III: Intrusion Detection and Prevention Systems Intrusion Detection and Prevention, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation.	**8**
Module – IV: Introduction to Digital Forensics Digital forensics fundamentals- Understanding digital forensics, its significance, and its role in cybersecurity; Types of Digital Forensics: Computer forensics, mobile device forensics, network forensics, multimedia forensics etc.; Steps involved in digital forensic investigations- Procedures for identifying and collecting digital evidence; Techniques for preserving the integrity of digital evidence; Maintaining and documenting the chain of custody.	**8**
Module – V: Digital Forensics Analysis and Tools Forensic Tools: Overview of commonly used tools in digital forensics (e.g., FTK, EnCase, Autopsy); Audio-video evidence collection, Preservation and Forensic Analysis. E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.	**8**

TEXTBOOKS:

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Nina Godbole and Sunit Belpure, Wiley Indian Print 2014.
2. Digital Forensics and Incident Response: Incident Response Techniques and Procedures to Respond to Modern Cyber Threats by Gerard Johansen.

REFERENCE BOOKS:

1. Anti-Hacker Tool Kit (Indian Edition) by Mike Shema, Publication Mc Graw Hill.
2. John R. Vacca, Computer Forensics: Computer Crime Scene Investigation, 2015, Second Edition, Charles River Media, Inc. (ISBN No.: 978-1-58450-389-7)
3. B. Nelson, A. Phillips, F. Enfinger, and C. Steuart, Guide to Computer Forensics and Investigations, 2019, Sixth Edition. CENGAGE, INDIA (ISBN: 9789353506261

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Quiz 1	10
Quiz 2	10
Quiz 3	10
Seminar Presentation	10
Assignment/ Assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Mini projects/projects

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

Grading: No Correlation – 0, Low Correlation - 1, Moderate Correlation – 2, High Correlation - 3

Mapping between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD4
CO5	CD1, CD4

COURSE INFORMATION SHEET

Course Code: CS673
Course Title: Data Compression Techniques
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3 L
Class: M. Tech.
Semester / Level: II/ II
Branch: CSE

COURSE OBJECTIVES

This course envisions to impart the students to:

1.	To understand the motivation, theoretical foundations, and types of data compression.
2.	To learn efficient, reversible data compression methods and their applications.
3.	To explore the theoretical and practical foundations of lossy compression systems.
4.	To study traditional and modern image, audio and video compression standards and methods.
5.	To gain experience doing independent study and research.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Understand the fundamental principles and theoretical foundations of data compression and classify different compression methods.
CO2	Apply lossless compression techniques such as Huffman coding, arithmetic coding, and dictionary-based methods to real-world data.
CO3	Analyze the performance and trade-offs of lossy compression systems using rate-distortion theory and quantization techniques.
CO4	Evaluate and compare image compression standards including JPEG and JPEG2000 based on performance metrics and application suitability.
CO5	Design and interpret audio and video compression workflows using state-of-the-art standards like MPEG and HEVC, including motion estimation techniques.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Fundamentals of Data Compression Motivation for Data Compression, Overview of Compression Types: Lossless vs Lossy, measures of performance, Applications of Data Compression, A brief introduction to information theory, Coding: Uniquely Decodable Codes, Prefix Codes, Kraft-McMillan Inequality	**6**
Module – II: Introduction to Lossless Compression Huffman Coding, Arithmetic Coding, Dictionary-Based Coding: LZ77, LZ78, LZW, Applications Dictionary-Based Coding, Context based Compression: CALIC and JPEG-LS	**8**
Module – III: Introduction to Lossy Compression Rate Distortion criteria, Scalar Quantization: Uniform, Non-uniform, Adaptive Quantization, Lloyd-Max Algorithm, Vector Quantization: Linde-Buzo-Gray algorithm, Trellis-Coded Quantization, Differential Encoding: DPCM, Delta Modulation, Image Coding	**8**
Module – IV: Image Compression Techniques JPEG Compression Standard: Transform Coding using DCT, Quantization, Zig-Zag Ordering, Entropy Coding, Subband Coding: Filter Banks, Polyphase Decomposition, Applications of Subband Coding, Wavelet-Based Image Compression (JPEG2000)	**8**
Module – V: Audio and Video Compression MPEG Audio Coding: Base and Advanced. Introduction to Video Compression, Motion Estimation and Compensation, Few Fast Motion Estimation Schemes, Video compression Standards: MPEG-1,2,4. H.264 and HEVC	**10**

TEXTBOOKS:

1. Khalid Sayood, Introduction to Data Compression, Elsevier, 4e

REFERENCE BOOKS:

1. Gilbert Held, Thomas R. Marshall, Data and Image Compression: Tools and Techniques, Wiley, 4e
2. Data Compression: The Complete Reference", By David Saloman, Springer
3. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, 3e

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Quiz 1	10
Quiz 2	10
Quiz 3	10
Seminar Presentation	10
Assignment/ Assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Mini projects/projects

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

Grading: No Correlation – 0, Low Correlation - 1, Moderate Correlation – 2, High Correlation - 3

Mapping between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD4
CO5	CD1, CD4

COURSE INFORMATION SHEET

Course Code: CS674
Course Title: Introduction to Blockchain Technology
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T: P:
Class schedule per week: 3L
Class: M. Tech.
Semester / Level: II/II
Branch: CSE
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	To provide an overview of the different blockchain technologies.
2.	To provide the knowledge of cryptocurrency design and its security against scam, fraud, hacking.
3.	To provide the ability to design and implement new ways of using blockchain for applications other than cryptocurrency.
4.	To be able to apply the knowledge gained through the course in actual blockchain development or blockchain contract development.
5.	To provide the knowledge of the applications of blockchains in various industries.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Learn and explain the difference between centralized, decentralized network and blockchain.
CO2	Explain fundamental concepts of blockchain using hashes and consensus.
CO3	Understand the concept of mining in blockchains.
CO4	Understand the working of Bitcoin and its security.
CO5	Know about the different platforms for implementing blockchain and its varied application.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Blockchain Technology:** Introduction to Blockchain, History of Blockchain, Trusted Third party for transactions, Difference between centralized, decentralized and distributed peer to peer networks, Types of Blockchain (Permission Blockchain vs. Permissionless Blockchain), Components and limitations of Blockchain. **Cryptographic Primitives:** Hash functions, Puzzle friendly Hash, Collison resistant hash, Digital signatures, public key cryptosystems, Zero-knowledge systems**.**	**8**
Module – II **Fundamental concepts of Blockchain:** Introduction to Bitcoins, Concepts of Block, Transactions: Recording transactions, Digital Signature, Verifying and confirming transactions, Blocks and blockchain: Hash pointers, Consensus building, Bitcoin downsides. Distributed consensus, Byzantine general problems, Consensus mechanism: POW, POS, POB, POA, Hybrid, etc. Blockchain Architecture, Markle Root Tree	**8**
Module – III **Mining and simulating blockchain:** Mining and simulating blockchain: Game theory behind competitive mining. Incentives: mining and transaction fees, Energy expended in mining. **Smart Contracts:** Definition, Lifecycle, History, Features, Types and Working, Contract deployment, access control, Smart contract vulnerability, Advantages and Challenges.	**8**
Module – IV **Cryptocurrency:** Bitcoin creation, exchanges. Wallets, Types of Wallets, and Cryptocurrencies (Monero, Zcash). Protecting blockchain from attackers. Forks – soft and hard, Blockchain security, Key Management in Bitcoin, LiteCoin, AltCoins, **Security:** Common attacks on Blockchain: 51% Attack, Sybil Attack, Replay attack, Double spending attack.	**8**
Module – V **Platforms and Applications:** Introduction to Blockchain platform: Ethereum, Hyperledger Fabric, EVM, IOTA, EOS, Multichain, Bigchain, CORDA, SOLIDITY, designing a new blockchain, Distributed Application (DAPP) Plug and Play Blockchain mechanism. **Applications:** Cybersecurity, E-Governance, Elections, Medical Information Systems, File sharing, Supply-Chain management, Payment channels.	**8**

TEXTBOOKS:

1. Bitcoin and Cryptocurrency technologies: a comprehensive introduction. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Princeton University Press, First edition,2016
2. Blockchain Applications: A Hands-On Approach. Arshdeep Bahga, Vijay Madisetti. VPT Publisher. First edition, 2018.
3. Blockchain: Step – by – Step Guide to Understand by Paul Laurence, Createspace Independent Pub.

REFERENCE BOOKS:

1. Introducing Ethereum and Solidity Foundations of Cryptocurrency and Blockchain Programming for Beginners by Chris Dannen, Apress
2. Blockchain: The comprehensive beginner's guide by Frank Walrtin

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Quiz 1	10
Quiz 2	10
Quiz 3	10
Seminar Presentation	10
Assignment/ Assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	**Lecture by use of boards/LCD projectors**
CD2	**Tutorials/assignments**
CD3	**Mini projects/projects**

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

Grading: No Correlation – 0, Low Correlation - 1, Moderate Correlation – 2, High Correlation - 3

Mapping between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD4
CO5	CD1, CD4

COURSE INFORMATION SHEET

Course Code: CS675
Course Title: Introduction to Blockchain Technology Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 2 L: T: P: 4
Class schedule per week: 4L
Class: M. Tech.
Semester / Level: II/ II
Branch: CSE
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Gain hands-on experience with Remix IDE and Solidity programming for creating smart contracts.
2.	Gain hands-on experience with Remix IDE and Solidity programming for creating smart contracts.
3.	Understand and implement deployment of smart contracts on Ganache using Truffle framework.
4.	Develop competence in full-stack blockchain application development using Web3 and Truffle.
5.	Apply blockchain concepts to design and implement small-scale real-time applications.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Design and implement smart contracts using Solidity on Remix IDE.
CO2	Create and configure crypto wallets (e.g., MetaMask) and perform transactions with accounts from Ganache.
CO3	Deploy smart contracts on Ganache using Truffle.
CO4	Develop full-stack blockchain applications integrating Web3 and blockchain frameworks.
CO5	Design and implement small-scale real-time blockchain applications.

SYLLABUS

MODULE	(NO. OF SESSIONS)
Module – I: Introduction **Metamask and Ethereum:** Creating accounts and Cryptowallets, depositing Ethers, making a transaction.	**3**
Module – II: Solidity Programming **Remix, Solidity and Smart Contracts:** Introduction to Solidity Programming, Address Binding, Error Handling, Remix IDE	**3**
Module – III: Smart Contracts **Smart Contract Deployment:** Compile and deploy smart contracts in Remix	**3**
Module – IV: Smart Contracts Interactions **Full Stack Blockchain:** Configuration of peers, transferring Ethers from one account to another, interacting with smart contracts	**2**
Module – V: Implementation Designing one Full-fledged Blockchain Application	**3**

TEXTBOOKS:

1. Bitcoin and Cryptocurrency technologies: a comprehensive introduction. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Princeton University Press, First edition,2016
2. Blockchain Applications: A Hands-On Approach. Arshdeep Bahga, Vijay Madisetti. VPT Publisher. First edition,2018.
3. Blockchain: Step – by – Step Guide to Understand by Paul Laurence, Createspace Independent Pub.

REFERENCE BOOKS:

4. Introducing Ethereum and Solidity Foundations of Cryptocurrency and Blockchain Programming for Beginners by Chris Dannen, Apress
5. Blockchain: The comprehensive beginner's guide by Frank Walrtin

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	% Distribution
Day to Day Performance	30
Quiz 1	10
Viva	20

Continuous Internal Assessment	% Distribution
End Sem Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Mini projects/projects

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

Mapping between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD4
CO5	CD1, CD4

COURSE INFORMATION SHEET

Course Code: CS676
Course Title: Security in Cyber Physical Systems
Pre-requisite(s): Basic Cryptography, Number Theory, Linear Algebra
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3 L
Class: M. Tech.
Semester / Level: II/ II
Branch: CSE

COURSE OBJECTIVES

This course envisions to impart the students to:

1.	Explain IoT and CPS architectures, components, and communication frameworks.
2.	Identify and analyze security threats, vulnerabilities, and risks in IoT and CPS systems.
3.	Explore lightweight cryptographic techniques, authentication, and secure communication protocols.
4.	Examine CPS security standards and protection mechanisms for critical infrastructures.
5.	Apply secure design, privacy preservation, and attack mitigation in real-world IoT/CPS deployments.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Describe IoT and CPS architecture and protocols from a security perspective.
CO2	Identify attack surfaces and vulnerabilities in IoT/CPS environments.
CO3	Apply lightweight cryptography, secure boot, and firmware protection for IoT devices.
CO4	Analyze CPS security risks in industrial, smart grid, and healthcare domains.
CO5	Design and evaluate secure IoT/CPS architectures using standards and privacy principles.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Internet of Things (IoT) and Cyber Physical Systems (CPS) Fundamentals and Architectures Internet of Things (IoT) Ecosystem: Devices, Sensors, Gateways, Cloud, and Edge, Cyber Physical Systems (CPS) Overview: Definition, Domains (Industrial, Smart Grids, Healthcare, Autonomous Systems), Communication Protocols: MQTT, CoAP, AMQP, 6LoWPAN, OPC UA, Security Challenges in IoT and CPS Architectures	**8**
Module – II: IoT and CPS Threats & Vulnerabilities Threat Landscape: Device Exploits, Network Attacks, Cloud Compromise, IoT Protocol Vulnerabilities (MQTT, CoAP, Zigbee), CPS Attack Scenarios: Stuxnet, Industroyer, Triton Case Studies, Threat Modeling for IoT/CPS	**8**
Module – III: Security Mechanisms for IoT Lightweight Cryptography (AES-CCM, PRESENT, SPECK), Authentication & Access Control (OAuth 2.0, DTLS, Secure Boot), Key Management, Secure Firmware Updates, and Over-the-Air (OTA) Security, Privacy Preservation Techniques in IoT Networks	**8**
Module – IV: CPS Security Standards and Frameworks CPS Security Standards: IEC 62443, NIST SP 800-82, Industrial Control System Security (ICS) Best Practices, Intrusion Detection Systems for CPS (Anomaly-based, Signature-based), Resilience and Redundancy in CPS Design	**8**
Module – V: Advanced Security Architectures & Case Studies Zero-Trust Security for IoT/CPS, Blockchain and Distributed Ledger for IoT Data Integrity, Privacy-by-Design Approaches for Smart Cities and Smart Grids, Real-World Security Implementations and Case Studies	**8**

TEXTBOOKS:

1. Buyya, R., & Dastjerdi, A. V. (Eds.). (2016). Internet of Things: Principles and paradigms. Elsevier.
2. Pathan, A. S. K. (Ed.). (2016). Security of Self-organizing Networks: MANET, WSN, WMN, VANET. CRC Press.

REFERENCE BOOKS:

1. Kleidermacher, D., & Kleidermacher, M. (2012). Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development. Elsevier.
2. Hu, F. (2016). Security And Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations. CRC Press.
3. Stouffer, K., Falco, J., & Scarfone, K. (2011). Guide to industrial control systems (ICS) security. NIST Special Publication, 800 (82), 16-16.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Quiz 1	10
Quiz 2	10
Quiz 3	10
Seminar Presentation	10
Assignment/ Assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Mini projects/projects

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

Grading: No Correlation – 0, Low Correlation - 1, Moderate Correlation – 2, High Correlation - 3

Mapping between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD4
CO5	CD1, CD4

COURSE INFORMATION SHEET

Course Code: CS677
Course Title: Quantum Cryptography
Pre-requisite(s): Basic Cryptography, Number Theory, Linear Algebra
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3 L
Class: M. Tech.
Semester / Level: II/ II
Branch: CSE

COURSE OBJECTIVES

This course envisions to impart the students to:

1.	To introduce the principles and threats posed by quantum computing to classical cryptographic systems.
2.	To study the design and security of post-quantum cryptographic algorithms.
3.	To explore lattice-based, code-based, multivariate, hash-based, and isogeny-based cryptography.
4.	To analyze the NIST standardization process for PQC algorithms.
5.	To develop the ability to implement and evaluate PQC schemes for practical security applications.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Understand the impact of quantum computing on classical cryptography.
CO2	Explain the mathematical foundations of post-quantum cryptographic schemes.
CO3	Compare different PQC families in terms of security and efficiency.
CO4	Analyze NIST-recommended PQC standards for practical deployment.
CO5	Implement and evaluate basic PQC algorithms in software or hardware.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Introduction to Post-Quantum Cryptography Classical cryptography review (RSA, ECC, AES), Quantum computing basics (Qubits, Superposition, Entanglement), Shor's Algorithm & Grover's Algorithm, Quantum threat to RSA, ECC, and symmetric schemes, Overview of Post-Quantum Cryptography (PQC) and NIST process	**8**
Module – II: Lattice-Based Cryptography Introduction to lattices (definitions, basis, reduction), Hard problems: SVP, CVP, LWE, RLWE, Lattice-based encryption schemes (NTRU, Kyber), Lattice-based signature schemes (Dilithium, Falcon), Security and efficiency considerations	**8**
Module – III: Code-Based and Multivariate Cryptography Code-based cryptography (McEliece, Niederreiter), Error-correcting codes and decoding problems, Multivariate Quadratic (MQ) schemes, UOV and Rainbow signature schemes, Security, key sizes, and performance	**8**
Module – IV: Hash-Based and Isogeny-Based Cryptography Hash-based signatures (XMSS, LMS, SPHINCS+), Merkle trees and one-time signatures, Super singular Isogeny Diffie–Hellman (SIDH/SIKE), Recent developments in isogeny cryptography, Comparative analysis of PQC families	**8**
Module – V: Implementation and Standardization NIST PQC Round 3 and 4 finalists and standards, Implementation considerations (performance, memory, hardware), Migration strategies to PQC in real-world systems (TLS, VPNs, blockchains), Security analysis and future research challenges, Case studies of PQC deployments	**8**

TEXTBOOKS:

1. Vidick, T., & Wehner, S. (2023). Introduction to Quantum Cryptography. Cambridge: Cambridge University Press.
2. Kollmitzer, C., & Pivk, M. (Eds.). (2010). Applied quantum cryptography (Vol. 797). Springer.
3. Hoffstein, J., Pipher, J., & Silverman, J. H. An Introduction to Mathematical Cryptography. Springer, 2nd ed., 2014.

REFERENCE BOOKS:

1. J. H. Silverman, A Friendly Introduction to Number Theory, 4th Ed. Boston: Pearson, 2019 (ISBN No.: 978 9353433079, 935343307X
2. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security: Private Communications in a Public World", Prentice Hall of India, Second Edition, 2016. (UNIT V).
3. Jao, D., & De Feo, L. Towards Quantum-Resistant Cryptosystems from Supersingular Elliptic Curve Isogenies. PQCrypto 2011.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Quiz 1	10
Quiz 2	10
Quiz 3	10
Seminar Presentation	10
Assignment/ Assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/assignments
CD3	Mini projects/projects

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium		high	high	high
CO2	high		medium	high	high	high
CO3	high	medium	medium	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

Grading: No Correlation – 0, Low Correlation - 1, Moderate Correlation – 2, High Correlation - 3

Mapping between Course outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD4
CO5	CD1, CD4