DEPARTMENT OF INFORMATION TECHNOLOGY
M. Tech. INFORMATION TECHNOLOGY

SEMESTER I					
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**
	Core Courses				**24**
ITY501	Fundamentals of Data Science	DCC-1	4	3-1-0	
ITY503	Distributed Systems	DCC-2	4	3-1-0	
ITY505	Applied Cryptography	DCC-3	4	3-1-0	
ITY507	Foundations of Machine Learning	DCC-4	4	3-0-2	
	Departmental Elective - I				
ITY511	Linear Algebra and Probability	DEC-1	4	3-1-0	
ITY513	Image Analysis			3-0-2	
ITY515	Malware Analysis			3-0-2	
ITY517	Mobile Computing			3-1-0	
ITY519	Embedded Systems			3-1-0	
ITY571	GPU Computing			3-1-0	
ITY573	Software Testing			3-0-2	
ITY575	Data Mining & Warehousing			3-1-0	
ITY577	Object-Oriented Software Engineering			3-0-2	
ITY579	Secure Coding			3-1-0	
	Skill Enhancement Course – 1				
ITY541	Dev Ops and ML Ops	SEC-1	2	0-0-4	
ITY543	IT Workshop			0-0-4	
ITY545	Mobile Application Development			0-0-4	
	Self-Study Course				
ITY551	Seminar	SSC	2		
ITY553	MOOC				
	Audit Course				
UEC501	English for Research Paper Writing	AUC	Non-Credit	2-0-0	
UEC503	Disaster Management			2-0-0	
UEC505	Sanskrit for Technical Knowledge			2-0-0	
UEC507	Value Education			2-0-0	
UEC509	Constitution of India			2-0-0	
UEC511	Pedagogy Studies			2-0-0	
UEC513	Stress Management by Yoga			1-0-2	
UEC515	Personality Development through Life Enlightening Skills			2-0-0	
UEC517	Indian Music			1-0-2	
UEC519	Sports and Rehabilitation			1-0-2	
UEC521	Multi-Dimensional Poverty Indices for Developing Countries			1-0-2	
SEMESTER II					

Course Code	Course Name	Course Type	Credit	L-T-P	Total Credits
	Core Courses				**24**
ITY502	Computer Vision	DCC-5	4	3-1-0	
ITY504	Network Security	DCC-6	4	3-0-2	
	Departmental Elective – 2				
ITY520	Deep Learning & Applications	DEC-2	4	3-0-2	
ITY522	Reinforcement Learning			3-1-0	
ITY524	Cyber Security & Law			3-1-0	
ITY526	Smart Sensing for Internet of Things			3-0-2	
ITY560	Pattern Analysis			3-1-0	
ITY562	FoG and Edge Computing			3-1-0	
ITY564	Advanced Algorithms and Analysis			3-1-0	
ITY566	Quantum Computing			3-1-0	
ITY568	Bioinformatics			3-1-0	
	Departmental Elective – 3				
ITY530	Generative AI	DEC-3	4	3-0-2	
ITY532	Data Engineering and Analytics			3-0-2	
ITY534	Multimodal Computing and Application			3-1-0	
ITY536	Digital and Cyber Forensics			3-0-2	
ITY538	Network and Internet of Things			3-1-0	
ITY580	Soft & Evolutionary Computing			3-0-2	
ITY582	Digital Watermarking & Steganalysis			3-0-2	
ITY584	Ethical Hacking			3-0-2	
ITY586	Multi-Agent Systems			3-1-0	
ITY588	Advanced Operating Systems			3-1-0	
	Skill Enhancement Course - 2 /Industrial Training				
ITY540	Industrial Training	SEC-2	4	0-0-8	
ITY542	Generative and Agentic AI			2-0-4	
UCC502	Research Methodology and IPR	UCC	4	3-1-0	
SEMESTER III					
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**
	Core Course				**16**
ITY601	Natural Language Processing	DCC-7	4	3-1-0	
	Open Elective				
OIT601	Quantum Computing and Applications	OEC	4	3-1-0	
ITY603	Minor Project/Research Thesis/Patent	DCC-8	8	-	
SEMESTER IV					
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**

ITY604	Major Project/Research Thesis/Patent	DCC-9	16	-	**16**

Details of Course:

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY501: Fundamentals of Data Science	3	1	0	Probability, statistics and linear algebra

Course Objective: To familiarize students with different types of data and its visualization along with data pre-processing, data modeling and data exploration to solve real-world analytical problems in data science.

Couse Outcome

Course Outcome (CO):

1. Ability to identify different types of data and data distributions.
2. Ability to understand and apply different data cleaning and data transformation techniques.
3. Ability to understand and implement different data visualization techniques.
4. Ability to understand and execute different data exploration techniques.
5. Ability to implement different real-world applications of data science.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1			2
CO2	1		2
CO3	1	2	2
CO4	1	1	2
CO5	1	1	3

Syllabus

S. No.	Content	Contact Hours
Unit 1	Introduction to data science: Basics of Probability & Statistics (Random Variables, Bayes's Theorem, Normal distribution, Central Limit Theorem). Defining data science, Recognizing different types of data, Data distributions. Data acquisition and data storage.	**10**
Unit 2	Data pre-processing: Missing data problem, Outlier definition. Data cleaning, Data transformation or data wrangling procedures such as merging, ordering and aggregating.	**10**
Unit 3	Data visualization: Introduction to data visualization, Challenges of data visualization. Definition of Dashboard, Dashboard design and principles. Basic charts and plots, Box plots, Histogram, Graphs, Networks, Hierarchies, Reports.	**10**
Unit 4	**Exploratory Data Analysis**: Data exploration for univariate data. Outlier detection techniques. Descriptive statistics (mean, standard deviation etc.) for data exploration. Correlation statistics for data exploration. Data exploration for multivariate data. Use of multivariate visualization tools such as bar charts, bar plots, heat maps, bubble charts, run charts, and scatter plots.	**12**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei, 3rd ed., Morgan Kaufmann	2022
2	Data science from scratch, Joel Grus, 2nd ed., O'Reilly Media.	2019
3	Python data science handbook, Jake VanderPlas, 2nd ed., O'Reilly Media.	2016
4	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, 2nd ed., O'Reilly Media.	2019
5	The data science handbook, Field Cady, John Wiley & sons.	2017

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY503: Distributed Systems	3	1	0	Fundamentals of Computer Networks, Operating Systems

Course Objective: 1. To understand fundamental concepts of distributed computing and to acquire knowledge to design and develop protocols for distributed systems and networks

Couse Outcome

Course Outcome (CO):

1. Able to apply knowledge of operating systems and networks to distributed systems
2. Design distributed algorithms for complex computing problems
3. Analyze the performance of algorithms and evaluate the scalability of solutions
4. Adapt existing centralized algorithms to a distributed setup
5. Simulate the algorithms in a distributed environment

CO-PO Articulation metri

	PO1	PO2	PO3
CO1	1		1
CO2			2
CO3			3
CO4	1		3
CO5	1		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	Fundamental issues in Distributed Systems, Models of Distributed Computations, Handling time through clocks, Physical Time and Hardware Clock Synchronization, Logical Time and Software Clocks, Message Ordering Protocols, Interprocess Communication, Shared Memory Vs Message Passing Models, Distributed and Localized Algorithms, Evaluation of Correctness and Performance.	**10**
Unit 2	Protocols for Routing and Designing Virtual Constructs, MST, MIS, and CDS, Distributed Mutual Exclusion, and Leader Election	**14**
Unit 3	Distributed Deadlock Detection, Termination Detection, Global State Computation and Snapshot Recording.	**12**
Unit 4	Global Predicate Detection, Fault-Tolerance Issues, Basic Techniques for handling Crash Failure in Distributed Systems, Checkpointing and Rollback Recovery, Z-path and Z-cycles, Other Types of Failures in Distributed Computing Systems, Consensus and Agreement Protocols, FLP Impossibility, Byzantine Generals Problem, Failure Detectors, Wait Freedom, Self-Stabilization, Peer-to-Peer Computing, Overlay Structures, Distributed Scheduling and Load Balancing, Naming, Security.	**12**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	A D Kshem kalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press.	2008
2	G Colouris, J Dollimore, and T Kindberg, Distributed Systems: Concepts and Design, 3/e Pearson Ed	2002
3	A S Tanenbaum and M van Steen, Distributed Systems: Principles and Paradigms, 3/e Pearson Ed.	2002
4	V K Garg, Principles of Distributed Systems, Kluwer Academic Publishers	1966
5	Sukumar Ghosh, Distributed Systems: An Algorithmic Approach, 2/e Chapman& Hall.	2014
6	Nancy Lynch, Distributed Algorithms, Morgan Kaufmann Press.	2020

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY505: Applied Cryptography	3	1	0	-

Course Objective: Learning the concept of Information security and mathematical tools for the implementation of various security.

Couse Outcome

Course Outcome (CO):

1. To understand the fundamentals of information security and encryption models.
2. To be able utilize a variety of modern block ciphers, DES and AES for encryption decryption.
3. To be able to apply Apply mathematical foundations and public key cryptographic techniques such as RSA, Diffie–Hellman, ElGamal, and Elliptic Curve Cryptography for secure communication and key exchange.
4. To Evaluate message authentication, hash functions, MACs, secure hash algorithms, and authenticated encryption techniques to ensure data integrity and authentication.
5. To be able to understand and implement digital signature schemes, cryptographic key management, public key distribution, X.509 certificates, and Public Key Infrastructure (PKI) concepts for secure systems.

CO-PO Articulation

	PO1	PO2	PO3
CO1	2		2
CO2	2		2
CO3	2		2
CO4	2		2
CO5	1	3	1

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Need for security, Introduction to security attacks, services and mechanism, introduction to cryptography, Conventional Encryption: Conventional encryption model, classical encryption techniques substitution ciphers and transposition ciphers, cryptanalysis, stereography, stream and block ciphers, Intruders, Viruses and related threads.	**6**
Unit 2	**Modern Block Ciphers**: Block ciphers principals, Shannon's theory of confusion and diffusion, fiestal structure, data encryption standard (DES), strength of DES, crypt analysis of DES, block cipher modes of operations, triple DES, Double DES and Triple DES. Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Key Expansion, An AES Example, AES Implementation. Electronic Codebook, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode, XTS-AES Mode for Block-Oriented Storage Devices,	**8**
Unit 3	**Public Key Cryptosystem:** ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primarily testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms, Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffle-Hellman key exchange algorithm, introductory idea of Elliptic curve	**8**

	cryptography, Elgamal encryption, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.	
Unit 4	**Message Authentication and Hash Function**: Authentication requirements, authentication functions, message authentication code (MAC), hash functions, security of hash functions and MACS, MACs Based on Hash Functions: HMAC, MACs Based on Block Ciphers: DAA and CMAC, Authenticated Encryption: CCM and GCM, Applications of Cryptographic Hash Functions, Requirements and Security, Secure hash algorithm(SHA	**8**
Unit 5	**Digital Signatures:** Digital Signatures, Properties, Attacks and Forgeries ,Digital Signature Requirements, Direct Digital Signature, ElGamal Digital Signature Scheme, Schnorr Digital Signature Scheme, NIST Digital Signature Algorithm, Elliptic Curve Digital Signature Algorithm, RSA-PSS Digital Signature Algorithm.	**6**
Unit 6	Cryptographic Key Management and Distribution: Symmetric Key Distribution Using Symmetric Encryption, Key Distribution Options, Third-Party Key Distribution Options, Key Hierarchy, Symmetric Key Distribution Using Asymmetric Encryption Simple Secret Key Distribution, Secret Key Distribution with Confidentiality and Authentication, Distribution of Public Keys, Public Announcement of Public Keys, Publicly Available Directory Public-Key Authority, Public-Key Certificates, X.509 Certificates, Public-Key Infrastructure.	**6**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	William Stallings, “Cryptography and Network Security: Principals and Practice”, Prentice Hall, New Jersy.	1999
2	Atul Kahate, “Cryptography and Network Security”, TMH.	2003
3	Behrouz A. Forouzan, “Cryptography and NetworkSecurity”, TMH.	2007
4	Johannes A. Buchmann, “Introduction to Cryptography”,Springer-Verlag.	1999
5	Bruce Schiener, “Applied Cryptography”.	2015

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY507: Foundation of Machine Learning	3	0	2	Basic probability theory and linear algebra

Course Objective: To describe various mathematical concepts like probability, statistics, and overview of different machine learning tasks like classification, clustering, regression..

Couse Outcome

Course Outcome (CO):

1. Describe basic understanding of linear algebra, probability theory and discriminant function.
2. Analyze and implement supervised learning algorithms like SVM, decision trees, neural networks for problem solving.
3. Investigate feature selection methods and mixture models.
4. Explain and implement reinforcement learning.
5. Describe Bayesian learning and Bias Variance trade off.
6. Discuss the recent trends and applications in machine learning.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1	1		1
CO2	1		1
CO3	1		3
CO4	1		2
CO5	1		1

Syllabus

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Linear Algebra, Probability Theory, Introduction to Bayesian Methods, Parametric Methods, Discriminant Functions.	**6**
Unit 2	**Supervised Learning:** Linear Regression models, classification, Linear discriminant analysis, Probably Approximately Correct (PAC) Learning, Learning Multiple Classes, Model Selection and Generalization, Support vector machine, Decision trees, Nearest neighbors, neural networks.	**8**
Unit 3	**Unsupervised Learning:** Clustering, Mixture Models, Latent Variables, Expectation-Maximization, Feature selection, Dimensionality Reduction, Factor/Component Analysis, Linear Discriminant Analysis.	**8**
Unit 4	**Genetic Algorithms:** Motivation, Genetic operators, Fitness function, Models of Evolution and Learning, Fuzzy Logic: Fuzzy sets and operations, Membership function, Classical sets, angular fuzzy sets.	**10**
Unit 5	**Reinforcement Learning:** Introduction, The learning task, Q learning, non-deterministic rewards and actions, Relationship to dynamic programming, Model-Based Learning.	**10**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Introduction to Machine Learning, E. Alpaydin, MIT Press, 2004	2004
2	Machine Learning: A probabilistic approach, David Barber, 2006.	2006
3	Network Security: Private Communication in a Public World, Charlie Kaufman, Radia Perlman and Mike Spencer, Prentice Hall.	2002
4	Machine Learning, Tom Mitchell, McGraw Hill, 1997	1997

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY511: Linear Algebra and Probability	3	1	0	Fundamentals of Mathematics

Course Objective: To provide students with a solid foundation in linear algebra and probability theory, enabling them to apply mathematical techniques and probabilistic models to solve problems in various fields.

Couse Outcome

Course Outcome (CO):

1. Understand the fundamental concepts of linear algebra and matrices, and their applications in various real-world applications.
2. Comprehend the significance of orthogonality, inner product, and orthonormal bases in vector spaces.
3. Understand the concept of random variables and random vectors, and their probabilistic interpretation in modelling uncertainty
4. Differentiate between statistical averages and ensemble averages and understand the concept of random processes.
5. Learning parameter estimation using moments and maximum likelihood.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	1		1
CO2			2
CO3			3
CO4	1		3
CO5	1		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to Linear Algebra and Matrices:** Matrices and Linear Transformations, Rank, Determinant, trace of a matrix. Solving simultaneous equations using matrices, Gaussian Elimination, Overdetermined and underdetermine systems, Inverse, pseudo inverse. Condition number of a matrix, eigenvalues, eigenvectors, singular values, singular vectors.	**9**
Unit 2	**Orthogonality:** Inner Product, Orthogonality, Gram-Schmidt Orthogonalization, Vector and Matrix Norms - Applications to optimization problems and graph theory, machine learning.	**8**

Unit 3	**Introduction to Random Variables and Random Vectors:** Discrete and continuous random variables, random vectors. Transformation of continuous random variables and vectors by deterministic functions. Density functions of transformed continuous random variables.	**9**
Unit 4	**Introduction to Random Processes:** Statistical averages, ensemble and time averages. Random process, Bernoulli random process, binomial process. Weak and strict sense stationarity of a random process.	**8**
Unit 5	**Estimation of parameters from data:** method of moments, method of maximum likelihood. Tests of fit: Chi- Squared, Student-t test. Cramer-Rao bound on estimators. Comparison of two different distributions of the same random variable/vector.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Linear algebra and its applications, Gilbert Strang, Cengage Learning, Fourth Edition	2006
2	Probability, Random Variables, and Stochastic Processes, Papoulis and Unnikrishnan, Fourth Edition	2002
3	Probability and Random Processes - an introduction for application scientists and engineers, W B Davenport, Mc Graw Hill	1970
4	Probability and Statistics with Reliability, Queuing, and Computer Science Applications - Kishore S Trivedi, PHI	1964
5	Linear Algebra (Second Edition), Kenneth Hoffman and Ray Kunze, Prentice Hall India	2013
6	Cheney and Kincaid Linear Algebra (Second Edition), Jones and Barlett Learning	2014

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY513: Image Analysis	3	0	2	Probability, statistics and linear algebra

Course Objective: The course aims to provide students with comprehensive knowledge and practical skills in image analysis, including techniques for image enhancement, restoration, segmentation, and the application of various algorithms to effectively interpret and process digital images.

Couse Outcome

Course Outcome (CO):

1. Understand the fundamental concepts of a digital image processing system.
2. Analyze images in the frequency domain using various transforms.
3. Evaluate techniques for image enhancement in the spatial and frequency domain.
4. Elucidate the mathematical modelling of image restoration.
5. Interpret image segmentation and representation techniques.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	1		
CO2	1		2
CO3	1		2
CO4	1	1	2
CO5	1	1	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Fundamental steps in DIP**: concept of visual information, image formation model, image sampling and quantization, digital image representation, spatial and gray level resolution, relationship between pixels, application of image processing system.	**8**
Unit 2	**Introduction to Multidimensional signals and systems:** 2D-Signals, 2D systems, classification of 2D system, 2D convolution, 2D Z-transform, Image Transform: 2DDFT, discrete cosine, discrete sine, Haar, Walsh, Hadamard, Slant, KL, SVD, Hough, Radon, Ridgelet.	**10**
Unit 3	**Image enhancement**: Spatial domain: linear transformation, image negative, grey level shifting, non-linear transformation, logarithmic transformation, exponential transformation, grey level slicing, bit plane slicing, image averaging, mask processing, histogram manipulations.	**8**
Unit 4	**Image Restoration:** Image Restoration – degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering	**8**
Unit 5	**Image Segmentation:** Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/

		Reprint
1	Rafael C. Gonzalez, Richard Eugene Woods “Digital Image Processing” 3rd Edition.	2008
2	Anil K. Jain, Fundamentals of Digital Image Processing Pearson.	2002
3	Kenneth R. Castleman, Digital Image Processing Pearson.	2006
4	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson	2011

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY515: Malware Analysis	3	0	2	-

Course Objective: To introduce fundamentals of malware and to set up a protected static and dynamic malware analysis environment. Learn various malware behavior monitoring tools and actionable detection signatures from malware indicators. Learn how to trick malware into exhibiting behaviors that only occur under special conditions.

Couse Outcome

Course Outcome (CO):

1. To list the goals of Malware Analysis and to define Malware Analysis techniques.
2. To employ and illustrate static malware analysis techniques.
3. To employ and illustrate dynamic malware analysis techniques.
4. To classify and describe malware functionalities and behaviors.
5. To be able to examine malwares with reverse engineering.
6. To be able to characterize malwares.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2	1		1
CO3	1	2	1
CO4		2	
CO5	2	2	2
CO6	2	2	2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	Introduction to malware, OS security concepts, malware threats, evolution of malware, malware types viruses, worms, rootkits, Trojans, bots, spyware, adware, logic bombs, malware analysis, static malware analysis, dynamic malware analysis.	**6**
Unit 2	X86 Architecture- Main Memory, Instructions, Opcodes and Endianness, Operands, Registers, Simple Instructions, The Stack, Conditionals, Branching, Rep Instructions, C Main Method and Offsets. Antivirus Scanning, Fingerprint for Malware, Portable Executable File Format, The PE File Headers and Sections, The Structure of a Virtual Machine, Reverse Engineering- x86 Architecture, recognizing c code constructs in assembly, c++ analysis, Analysing Windows programs, Anti-static analysis techniques-obfuscation, packing, metamorphism, and polymorphism.	**8**
Unit 3	Live malware analysis, dead malware analysis, analyzing traces of malware-system-calls, api-calls, registries, network activities. Anti-dynamic analysis techniques-anti-vm, runtime-evasion techniques, Malware Sandbox, Monitoring with Process Monitor, Packet Sniffing with Wire shark, Kernel vs. User-Mode Debugging, OllyDbg, Breakpoints, Tracing, Exception Handling, Patching	**7**
Unit 4	Downloader, Backdoors, Credential Stealers, Persistence Mechanisms, Privilege Escalation, Covert malware launching- Launchers, Process	**8**

	Injection, Process Replacement, Hook Injection, Detours, APC injection.	
Unit 5	Signature-based techniques: malware signatures, packed malware signature, metamorphic and polymorphic malware signature non-signature-based techniques: similarity-based techniques, machine-learning methods, invariant inferences	**7**
Unit 6	Malware Characterization, Case Studies – Plankton, DroidKungFu, AnserverBot, Smartphone (Apps) Security.	**6**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Practical malware analysis The Hands-On Guide to Dissecting Malicious Software by Michael Sikorski and Andrew Honig ISBN-10: 1-59327-290-1, ISBN-13: 978-1-59327-290-6	2012
2	Android Malware by Xuxian Jiang and Yajin Zhou, Springer ISBN 978-1-4614-7393-0	2005
3	Hacking exposed™ malware & rootkits: malware & rootkits security secrets & Solutions by Michael Davis, Sean Bodmer, Aaron Lemasters, McGraw-Hill, ISBN: 978-0-07-159119-5	2010
4	Windows Malware Analysis Essentials by Victor Marak, Packt Publishing	2015

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY517: Mobile Computing	3	1	0	Computer Networks

Course Objective: To learn the fundamental concepts of Mobile Computing.

Couse Outcome

Course Outcome (CO):

1. To understand the fundamentals of mobile computing.
2. To acquire the knowledge of mobile communication systems.
3. To implement the various protocols related at network layer and transport layer.
4. To understand the server management in mobile computing.
5. To implement the concept of mobile ad hoc network for latest applications.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2			
CO3	1		2
CO4			2
CO5	1		2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	INTRODUCTION: Mobile Communication-Mobile Computing-Mobile Computing Architecture-Mobile devices-Mobile System Networks – Data dissemination – Mobile management- Security. Mobile Device and Systems	**8**
Unit 2	GSM AND SIMILAR ARCHITECTURES: GSM – services and architectures – Radio interfaces – Protocols – Localization – Calling – Handover – Security – New data services – General packet radio service- High speed circuit switched data – DECT. WIRELESS MEDIUM ACCESS CONTROL BASED COMMUNICATION-Medium Access Control.	**8**
Unit 3	MOBILE IP NETWORK LAYER AND MOBILE TRANSPORT LAYER: IP and mobile Network layers – Packet Delivery and Handover Management – Location management – Registration – Tunneling and Encapsulation - Route Optimization - Dynamic Host Configuration Protocol. Conventional TCP/IP Transport Layer Protocols – Indirect TCP – Snooping TCP – Mobile TCP – Other methods of mobile TCP – layer transmission – TCP over 2.5G/3G Mobile networks.	**9**
Unit 4	SERVER AND MANAGEMENT: Mobile agent – Application server – Gateways – Portals -Service Discovery – Device management – Mobile file systems-Security.	**8**
Unit 5	MOBILE AD HOC AND WIRELESS SENSOR NETWORKS: Introduction to mobile Ad hoc network –MANET, Wireless Sensor Networks & Applications.	**9**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Raj Kamal, "Mobile Computing", Oxford Higher education, Second Edition, 2007	2007
2	Jochen Schiller, "Mobile Communications", Addison-Wesley, 2nd Edition. 2004	2004
3	Lother Merk, Martin S. Nicklaus and Thomas Stober, "Principle of Mobile Computing", Second Edition, Springer.	2003
4	William C.Y. Lee, "Mobile Communication Design Fundamentals", John Wiley.	1995

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY519: Embedded Systems	3	1	0	

Course Objective: To introduce students to the Embedded systems algorithm concepts and their implementation, focusing on programming.

Couse Outcome

Course Outcome (CO):

1. To learn the design issues, Goals and Applications of embedded systems.
2. To differentiate and compare various microcontrollers and assembly languages.
3. To learn fundamentals of programming in C.
4. To learn assembly level programming.
5. To perform coding of I/O controller and necessary peripheral devices.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2			
CO3	2		2
CO4	2		2
CO5	2		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** fundamentals of embedded systems, embedded system architecture, classifications of embedded systems, fundamentals of embedded processor and microcontrollers, embedded software in a system, examples of embedded systems. CISC vs. RISC.	**6**
Unit 2	**The 8051 Architecture:** 8051 microcontrollers, I/O Ports and Circuits, Timers Counters, Serial Interface, Interrupts. 8051 Assembly Language Programming: Registers in the 8051, 8051 Assembly Assembling and Running an 8051 Programs.	**7**
Unit 3	**Programming in C:** Fundamental concepts of C programming, Examples on different concepts, Control structure, Functions, Storage classes, Pointers, structure, union, object-oriented programming, Assembly language intro, memory organization.	**5**
Unit 4	**Assembly language programming:** Instruction set and Programming, Immediate Addressing, Register Addressing Direct Addressing, Indirect Addressing, Indexed Addressing.	**7**
Unit 5	**I/O Programming:** PIC I/O ports, I/O bit manipulation programming, timers/counters, programming to generate delay and waveform generation, I/O programming.	**6**
Unit 6	**PIC Microcontrollers:** Introduction PIC Microcontroller, PIC16F877A Architecture and Instruction Set, I/O Ports and SFRs, Interrupts, Timers.	**5**
Unit 7	**Serial Communication Protocols**: Introduction to Timers & Counters, Difference between Timer and Counter.	**6**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Shibu K. V. (TMH), Introduction to Embedded Systems, McGraw Hill Education (15 June 2009)	2009
2	F. Vahid (John Wiley), Embedded System Design – A unified hardware and software introduction, John Wiley & Sons; ISBN: 0471386782. Copyright (c) 2002.	2002
3	Chuck helebuyck, Programming PIC microcontrollers with PIC basic; 1st Edition (later printing) edition (December 6, 2002).	2002

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY571: GPU Computing	3	1	0	

Course Objective: The course aims to provide students with a comprehensive understanding of GPU architecture and parallel computing.

Couse Outcome

Course Outcome (CO):

1. To import basic knowledge of GPU architecture and usage, features and security aspects.
2. To learn the languages, compilers, and data management required for GPU computing.
3. To learn how to preserve a data's availability, integrity, and confidentiality.
4. To recognize various network security procedures in order to defend against threats in networks.
5. To be able to assess system security in relation to the proper application of security services and methods.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1			
CO2	2		2
CO3	2		2
CO4	2		2
CO5		2	2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** History, GPU Architecture, Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel Programming, CUDA OpenCL / OpenACC, Kernels Launch parameters, Thread hierarchy, Warps/Wavefronts, Threadblocks/Workgroups, Streaming multiprocessors, 1D/2D/3D thread mapping, Device properties, Simple Programs.	**8**
Unit 2	**Memory:** Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories	**9**
Unit 3	**Synchronization:** Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.	**9**
Unit 4	**Support:** Debugging GPU Programs. Profiling, Profile tools, Performance aspects Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based-Synchronization - Overlapping data transfer and kernel execution, pitfalls.	**8**
Unit 5	**Advanced topics:** Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing.	**8**
Total		**42**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Shibu K. V. (TMH), Introduction to Embedded Systems, McGraw Hill Education	2009
2	F. Vahid (John Wiley), Embedded System Design – A unified hardware and software introduction, John Wiley & Sons; ISBN: 0471386782. Copyright (c)	2002
3	Chuck helebuyck, Programming PIC microcontrollers with PIC basic; 1st Edition (later printing)	2002

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY573: Software Testing	3	0	2	Software Engineering

Course Objective: provide students with the essential knowledge and practical skills required to conduct comprehensive software testing, ensuring the delivery of high-quality software products through various testing techniques and methodologies.

Couse Outcome

Course Outcome (CO):

1. Demonstrate a comprehensive understanding of the fundamental concepts of software testing

2. Apply functional testing techniques to design and execute test cases effectively.

3. Implement structural testing methods to identify and uncover defects in software systems.

4. Demonstrate proficiency in regression testing practices to ensure software quality during maintenance and evolution.

5. Exhibit competency in various software testing activities and gain knowledge of automated software testing tools.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1			
CO2	1		2
CO3	2		2
CO4	2		2
CO5	2		2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Software Failures, Testing Process, Some Terminologies, Limitations of Testing, The V- shaped Software Life Cycle Model	**8**
Unit 2	**Functional Testing:** Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique, Essentials of Graph Theory-Graph Introduction, Matrix Representation of Graphs, Paths and Independent Paths, Generation of a Graph from Program, Identification of Independent Paths.	**8**
Unit 3	**Structural Testing:** Control Flow Testing, Data Flow Testing, Slice Based testing, Mutation Testing. Software Verification: Verification Methods, Software Requirements Specification (SRS) Document, Software Design Description (SDD) Document, Source Code Reviews, User Documentation, Verification.	**8**
Unit 4	**Regression Testing:** Regression Test Cases selection, Reducing the number of Test Cases, Risk Analysis, Code Coverage, Prioritization Technique.	**8**
Unit 5	**Software Testing Activities:** Levels of Testing, Debugging, Software Testing Tools-Methodology to evaluate automated testing. Using tools: Load Runner, Win runner and Rational Testing Tools, Java Testing Tools, JMetra, JUNIT Cactus and other recent tools., Software Test Plan. Metrics and Models in Software Testing: Software Metrics, Categories of Metrics, Object- Oriented Metrics Used in Testing, Measures during testing, Software Quality Attributes Prediction Models	**10**
Total		**42**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Software Testing by Yogesh Singh, First edition, Cambridge University Press	2012
2	Software engineering by K.K.Aggarwal and Yogesh Singh, Fourth edition, New Age International Publishers	2022
3	Software Testing: Principles and Practices by Srinivasan Desikan and Gopalaswamy Ramesh, Pearson	2005
4	Schaum's Outlines, Problems of Software Engineering by David Gustafson, McGRAW-HILL	2002

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY575: Data Mining & Warehousing	3	1	0	Basic course on probability and statistics

Course Objective: To familiarize the student with data mining and warehousing fundamentals to enable the student to process, store and analyse large volumes of noisy multi-variate data found in real-world application domains.

Couse Outcome

Course Outcome (CO):

1. To understand the fundamentals of data mining and data warehousing.
2. To implement data pre-processing and analyze data with multiple attributes.
3. To execute association rule mining and item-set mining.
4.To describe the implementation of a data warehouse project and its management.
5. To explore case studies for data storage and data warehouse in practical applications.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2	2		3
CO3	2		3
CO4	2		3
CO5	2		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to data mining and warehousing**: types of databases for data mining, functionalities of data mining, classification of data mining systems, task primitives, integration of data mining with database, issues of data mining, Pivot Tables, Relational Database, Database Normalization, normal forms, SQL, Data Warehousing fundamentals.	**8**
Unit 2	**Data Objects and Attribute Types:** Nominal Attributes, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation.	**6**
Unit 3	**Data cube computation and data generalization**: Associations and correlations-basic concepts, efficient and scalable frequent item sets mining methods, mining various kinds of association rules, constraint-based association mining.	**8**
Unit 4	**Data Warehouses and Data Marts:** Overview of the components, Metadata in the Data Warehouse, Planning and Project Management: Planning Your Data Warehouse, The Data Warehouse Project, Architectural Components: Understanding Data Warehouse Architecture, Infrastructure Supporting Architecture, Collection of Tools	**10**
Unit 5	**Data design and data preparation:** From Requirements to Data Design, The STAR Schema, STAR Schema Keys, Advantages of the STAR Schema, Data Extraction, Data Transformation, Data Loading. **OLAP in the Data Warehouse:** Demand for Online Analytical Processing, Major Features and Functions, OLAP Models. Implementation and maintenance: physical design steps, physical design considerations, physical storage, indexing the data warehouse, performance enhancement techniques.	**10**
Total		**42**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Han, Kamber, “Data Mining Concepts and Techniques”, Morgan Kaufmann.	2000
2	M.H. Dunham, “Data Mining Introductory and Advanced Topics”, Pearson Education.	2002
3	Ralph Kimball, “The Data Warehouse Lifecycle toolkit”, John Wiley.	1996
4	Paulraj Ponniah, “Data Warehousing Fundamentals”, John Wiley.	2001

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY577: Object Oriented Software Engineering	3	0	2	Software Engineering

Course Objective: To understand basic methodology of object-oriented software engineering and learn to create UML diagrams at various phases of software development life cycle using real-life case studies.

Couse Outcome

Course Outcome (CO):

1. Understand object-oriented system concepts and development methodologies.
2. Use of UML 2.0 for static and dynamic modeling of object-oriented systems.
3. Understand the Unified Process (UP) and its applications in software development, including logical architecture design and use case modeling.
4. Proficient in applying creational, structural, and behavioral design patterns to solve common software design problems.
5. Apply object-oriented testing techniques and metrics to evaluate the quality and reliability of software systems.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1		2	
CO2		2	
CO3		2	
CO4	2	2	2
CO5		2	2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Object Oriented system concepts and Principles, Object Oriented system development, Component reuse, The common process framework for Object Oriented processes, System Development and Methodologies, object-oriented software estimation.	**8**
Unit 2	**UML 2.0** – Objects and Classes, Object Relationships, Inheritance and Polymorphism, Aggregation and Composition; Static Modeling Notation- Package Diagrams, Composite Structures, Component Diagrams, Deployment Diagram; Dynamic Modeling Notation- Use Case Diagrams, Activity Diagrams, Interaction Diagrams	**8**
Unit 3	**The Unified Process and its Applications:** Introduction to Unified Process, Relationship between UP, UML and OO design, what is a logical architecture? UML Package Diagrams, Inception- Use cases, System Sequence Diagrams, Domain Model, Operation Contracts	**8**
Unit 4	**Patterns:** Uses of Design Patterns, Types- Creational, Structural and Behavioural Design Patterns.	**8**
Unit 5	**Object Oriented Testing and metrics:** Path Testing, State based testing, Class Testing, object-oriented metrics. Applications & Tools: A complete case study of Software development using above Methodologies, Concepts of Computer-Aided Software Engineering and knowledge about current CASE tools use in the industry.	**10**
Total		**42**

Books:

. No.	Name of Books/Authors/ Publisher	f Publication/ Reprint
1	g UML and Patterns, Craig Larman, Prentice Hall,	2005
2	fied Modeling Language User Guide, Second Edition, G. Booch, J. Rumbaugh and son,	2005
3	edition, Addison Wesley	2005
4	nd the Unified Process, Jim Arlow and Ila Neustadt, Addison Wesley	2007
5	Oriented Software Engineering by I. Jacobson, M. Christerson, P. Jonsson, G. rd 2nd	2012

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY579: Secure Coding	3	1	0	-

Course Objective: Equip participants with a comprehensive understanding of cybersecurity fundamentals, proactive security development processes, threat modeling techniques, and secure coding practices to mitigate risks and safeguard systems against a range of threats including malware, access control breaches, and web-specific vulnerabilities

Couse Outcome

Course Outcome (CO):

1. Demonstrate an understanding of cybersecurity principles, including the CIA Triad and various types of malwares, to identify and mitigate security threats effectively.
2. Implement proactive security development processes, including threat modeling and threat rating using techniques like Attack Trees and DREAD, to assess and prioritize security risks.
3. Apply access control mechanisms and encryption techniques to protect sensitive data and mitigate common software security vulnerabilities such as format string problems and integer overflow.
4. Implement secure coding practices, including buffer overrun prevention and handling of socket security issues, to develop robust and resilient software systems.
5. Analyze and address database and web-specific security issues, including SQL injection and race conditions, and employ secure coding techniques to defend against attacks such as DoS and ARP spoofing.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1		2	
CO2	2	2	3
CO3	2	2	3
CO4	2		3
CO5	2	2	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Security, CIA Triad, Viruses, Trojans, and malware The need for secure system, proactive security development process, Threat modelling process and its benefits, Identifying the Threats by Using Attack Trees and rating threats using DREAD, cross-site scripting.	**8**
Unit 2	Access control, protecting secret data, Format String Problems, Integer Overflow, and Software Security Fundamentals, Buffer Overrun- Stack overrun, Heap Overrun, Array Indexing Errors.	**8**
Unit 3	Socket security, Avoiding Server Hijacking, Securing RPC, ActiveX and DCOM, secure .NET code, Command Injection, Failure to Handle Errors, and Security Touchpoints, Java Programming with Crypto API.	**8**
Unit 4	Proactive Security development process, Secure Software Development Cycle (S-SDLC), Security issues while writing SRS, Design phase security, Development Phase, Test Phase. Database and Web-specific issues: SQL Injection Techniques and Remedies, Race conditions, Time of Check Versus Time of Use and its protection mechanisms.	**10**
Unit 5	**Secure Coding Techniques:** Protection against DoS attacks, Application Failure Attacks, CPU Starvation Attacks, Insecure Coding Practices In Java Technology. ARP Spoofing.	**8**

Total	42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Michael Howard and David LeBlanc, Writing Secure Code, Microsoft Press, 2nd Edition	2004
2	Jason Deckar,Syngress , Buffer Overflow Attacks: Detect, Exploit, Prevent,1st Edition.	2005
3	Frank Swiderski and Window Snyder, Threat Modeling, Microsoft Professional, 1st Edition	2004

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY541: Dev Ops and ML Ops	0	0	4	Programming Fundamentals

Course Objective: To have a thorough understanding of programming with Python language for research and application development purpose.

Couse Outcome

Course Outcome (CO):

1. Explain the core principles of DevOps and MLOps, including collaboration, automation, and continuous delivery.
2. Describe the benefits and challenges of implementing DevOps and MLOps practices.
3. Apply version control systems (VCS) like Git and infrastructure as code (IaC) tools like Terraform or Ansible.
4. Utilize configuration management tools (e.g., Puppet, Chef) and CI/CD pipelines (e.g., Jenkins, GitLab CI/CD) to automate software deliver.
5. Employ containerization and orchestration technologies (e.g., Docker, Kubernetes) for efficient deployment and management of applications and ML models.

CO-PO Articulation Metrics

	PO1	PO2	PO3
CO1	2		2
CO2	2		2
CO3	1		2
CO4	2		2
CO5	2		2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	What is DevOps and MLOps? Core principles of DevOps and MLOps (collaboration, automation, continuous delivery) Benefits and challenges of implementing DevOps and MLOps The Machine Learning Lifecycle DevOps vs MLOps: Similarities and Differences.	**6**
Unit 2	Version Control Systems (VCS) - Git Infrastructure as Code (IaC) - Terraform, Ansible Configuration Management Tools - Puppet, Chef Continuous Integration and Continuous Delivery (CI/CD) Pipelines - Jenkins, GitLab CI/CD Containerization and Orchestration - Docker, Kubernetes	**6**
Unit 3	Machine Learning Model Training and Experimentation Data Versioning and Management Model Packaging and Deployment Monitoring, Logging, and Alerting for ML models MLOps Tools - MLflow, Kubeflow	**6**
Unit 4	Introduction to Cloud Computing (AWS, Azure, GCP) Cloud-based DevOps and MLOps tools Infrastructure Provisioning and Management on Cloud Platforms	**5**

Unit 5	Security Considerations in the Machine Learning Lifecycle Model Explainability and Bias Detection Data Governance and Privacy, A/B Testing and Model Serving Continuous Learning and Model Retraining DevOps for Data Science Teams (DataOps) Case Studies: Implementing MLOps in Real-World Projects	**5**
Total		**28**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition)	2019
2	Head-First Python: A Brain-Friendly Guide (2nd Edition)	2016
3	Python Programming: An Introduction to Computer Science (3rd Edition)	2016
4	Python Cookbook: Recipes for Mastering Python 3 (3rd Edition)	2013

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY543: IT Workshop	0	0	4	-

Course Objective: The IT Workshop is a training lab. The modules include training on PC Hardware, Internet & World Wide Web and Productivity tools including Word, Excel, PowerPoint and Publisher.

Couse Outcome

Course Outcome (CO):

1. Perform Hardware troubleshooting.
2. Understand Hardware components and inter dependencies.
3. Safeguard computer systems from viruses/worms
4. Document/ Presentation preparation using LaTeX and Word.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	2		
CO2	2	2	
CO3	2	2	
CO4	2	3	

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**PC Hardware:** Identification of basic peripherals, assembling a PC, installation of operating system like Linux or MS windows, installation of system software like MS Windows, device drivers. Troubleshooting Hardware and software some tips and tricks.	**6**
Unit 2	**Internet & World Wide Web:** Different ways of hooking the PC on to the internet from home and workplace and effectively usage of the internet, web browsers, email, newsgroups and discussion forums. Search Engines & Netiquette	**6**
Unit 3	**Cyber Hygiene:** Awareness of cyber hygiene (protecting the personal computer from getting infected with the viruses), worms and other cyber attacks	**4**
Unit 4	**Productivity tools: LaTeX and Word:** Using LaTeX and Word to create project certificate. Typing Research papers in some standard template of Conference/journal	**5**
Total		**21**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Comdex Information Technology course tool kit Vikas Gupta, WILEY Dreamtech	2005
2	The Complete Computer upgrade and repair book, 3rd edition Cheryl A Schmidt, WILEY Dreamtech	

3	PC Hardware - A Handbook – Kate J. Chase PHI (Microsoft)	2004
4	LaTeX Companion – Leslie Lamport, PHI/Pearson.	1994
5	IT Essentials PC Hardware and Software Companion Guide Third Edition by David Anfinson and Ken Quamme. – CISCO Press, Pearson Education	2008

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY545: Mobile Application Development	0	0	4	-

Course Objective: Master the fundamentals of Android development, covering native application creation, UI design, data handling, user experience enhancement, multimedia integration, , empowering students to build robust and feature-rich Android applications.

Couse Outcome

Course Outcome (CO):

1. Develop native Android applications utilizing the Android SDK and understanding the Open Handset Alliance framework.

2. Design intuitive user interfaces, manage application components, and leverage system permissions effectively.

3. Implement file and database handling techniques, ensuring efficient data storage and backup solutions.

4. Enhance user experience through multimedia integration, wireless connectivity, and telephony features, enabling you to build comprehensive and functional Android applications.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	2		
CO2	2		1
CO3	2		1
CO4	2		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to Android:** Native Android Application; SDK Features; Introduction to Open Handset Alliance; Development Framework; Application Fundamentals; Device Compatibility; System permissions.	**5**
Unit 2	**User Interface and Application Components**: Basic UI Design; Fragments; Widget Toolbox; Creating New View; Introduction to Intents; Intent Filters and broadcast Receivers; Activities; Services; Content Providers; Application Widgets; Processes and Threads.	**5**
Unit 3	**Files and Database Handling:** Saving Application Data; Shared Preferences; Preference Framework and Activity; Static File as Resource; File System	**4**
Unit 4	**Introduction to SQLite Database**; Querying SQLite; Storage options; Data backup User Experience Enhancement: Action Bar; Menus and Action Bar Items; Settings; Dialogs; Customizing Toast; Notifications; Search; Drag and Drop Multimedia. **Wireless Connectivity and Telephony**: Audio and Video Handling; Manipulating Raw Audio; Managing Wireless Connectivity: Wi-Fi, Bluetooth, Near Field Communication; Hardware Support for Telephony; Telephony Management; SMS and MMS.	**7**
Total		**21**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Reto Meier, “Professional Android 4 Application Development”, Wrox	2012
2	Matt Gifford, “PhoneGap Mobile Application Development Cookbook”, PACKT	2012
3	Adrian Kosmaczewski, “Mobile JavaScript Application Development”, O’RELLY	2012

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY502: Computer Vision	3	0	2	Image Processing

Course Objective: To learn fundamental computer vision algorithms and basic machine learning frameworks necessary for the automated understanding of images and videos. This includes object recognition from images, activity/event recognition from videos, scene segmentation and clustering, motion and tracking, and deep learning for images and videos.

Couse Outcome

Course Outcome (CO):

1. To describe Image Formation Models, Monocular imaging system, Orthographic & Perspective projections.
2. To evaluate applications of 2D/3D Vision Filters, Binary Images, Features and Edge Detection.
3. To describe Image Processing and Feature Extraction concepts.
4. To analyze motion Estimation, Regularization theory, Optical computation, Stereo Vision.
5. To investigate Shape Representation Segmentation, Deformable curves and surfaces.
6. To explain about Object recognition, describe Hough transforms and other simple object recognition methods.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	2		1
CO2	2		1
CO3	2		1
CO4	2		1
CO5	2		1

Syllabus:

S. No.	Content	Contact Hours
Unit 1	Image Formation Models: Monocular imaging system, Orthographic & Perspective Projection, Camera models and Camera calibration, Sources, shadows and shading.	**6**
Unit 2	Image Processing: Image representation, feature extraction and matching, Image filters, Edge detection, Image texture analysis, Clustering, Model Fitting	**6**
Unit 3	Motion Estimation: Regularization theory, Optical computation, Multi-view scene processing, depth recovery from Stereo Vision, Motion estimation, Structure from motion.	**8**
Unit 4	Shape Representation and Segmentation: Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multi-resolution analysis.	**8**
Unit 5	Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Tracking with linear dynamical models.	**8**
Unit 6	Object detection and tracking: Tracking with linear dynamical models, Optical flow estimation, Object tracking using deep neural networks.	**6**
Total		**42**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	D. Forsyth and J. Ponce ,Computer Vision - A modern approach, Prentice Hall	2013
2	Linda Shapiro and George Stockman, Computer Vision, Prentice-Hall, 2001.	2001
3	Szeliski, Richard. Computer vision: algorithms and applications. Springer Science & Business Media, 2010.	2010
4	E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Publisher: PHI COMPUTER SECURITY.	1994

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY504: Network Security	3	0	2	

Course Objective: To understand the principles of network security and associated threats and cryptographic mechanism.

Couse Outcome

Course Outcome (CO):

1. Analyze fundamental cybersecurity concepts, including security attacks, services, mechanisms, and cryptographic principles, and evaluate their role in securing network infrastructures.
2. **Implement** transport-level security protocols (TLS, HTTPS, SSH) and **assess** their effectiveness in protecting web-based and remote communication channels
3. **Design** security solutions for wireless networks, email systems, and IP-based communications using standards such as IEEE 802.11i, S/MIME, SPF, and IPsec to mitigate vulnerabilities.
4. **Evaluate** cloud and IoT security risks, **apply** countermeasures, and **demonstrate** the use of open-source security modules to protect distributed and smart environments.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1	1		2
CO2	2		2
CO3	2	1	2
CO4	2	2	2

Syllabus

S. No.	Content	Contact Hours
UNIT 1	Network Security Concepts: Cyber Security, Information Security and Network Security Concepts. The OSI Security Architecture, Security Attacks, Security Services, Security Mechanism, Cryptography, Network Security, Trust and Trustworthiness. Transport-level Security: Web Security Considerations, Transport Layer Security, HTTPS, Secure Shell (SSH).	**10**
UNIT 2	Wireless Network Security: Wireless security, Mobile Device Security, IEEE 802.11 Wireless Lan Overview, IEEE 802.11i wireless Lan Security. Electronic Mail Security: Internet Mail Architecture, Email formats, Email Threats and Comprehensive Email Security. S/MIME, DNSSEC, DNS-Based Authentication of Named Entities, Sender Policy Framework, Domain Keys identified mail, Domain-based Message Authentication, Reporting, and Conformance.	**11**
UNIT 3	IP Security : IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet key Exchange. Network End Point Security: Firewalls, Intrusion Detection System, Malicious Software, Distributed Denial of Service Attacks.	**11**
UNIT 4	Cloud Security: Cloud Computing, Cloud Security Concepts, Cloud Security Risks and Countermeasures, Cloud Security as a service, An Open - source Cloud Security Module. An open-Source Cloud Security Module. Internet of Things (IOT) Security: The Internet of Things, IOT Security Concepts and objectives, An open-Source IOT Security Module.	**10**

Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross	2020
2	Network Security Essentials: Applications and Standards" by William Stallings,	2017
3	Network Security: Private Communication in a Public World" by Charlie Kaufman, Radia Perlman, and Mike Speciner	2002
4	Cryptography and Network Security: Principles and Practice" by William Stallings,	2019
5	"Firewalls and Internet Security: Repelling the Wily Hacker" by William R. Cheswick, Steven M. Bellovin, and Aviel D. Rubin	2003

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY520: Deep Learning and Applications	3	0	2	-

Course Objective: To provide students with an in-depth understanding of deep learning concepts and architectures, including neural networks, convolutional networks, recurrent networks, and their applications.

Couse Outcome

Course Outcome (CO):

1. Understand the foundation and scope of Deep Neural networks.
2. To Explore predicate logic and its applications to understand knowledge representation.
3. To solve rule-based systems, Resolution, and semantic nets and frames.
4. To implement probabilistic reasoning and inferencing systems.
5. To Study AI-based expert systems, including architecture, domain knowledge, and knowledge acquisition.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2	3		3
CO3	3		3
CO4	3		3
CO5	3		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	Introduction: Basics of deep learning, Importance of deep learning, Feature engineering, Overview of deep learning framework.	**6**
Unit 2	Machine Learning Basics: Supervised learning algorithms, Hyper parameters and validation sets, overfitting, under fitting, Unsupervised learning algorithms, Stochastic Gradient Descent, Challenges motivating Deep Learning.	**9**
Unit 3	Deep feed forward network: Artificial Neural Network, activation function, multi-layer neural network, Training Neural Network: Risk minimization, loss function, backpropagation, regularization, model selection, and optimization, Data Augmentation, Dropout.	**9**
Unit 4	Convolutional Networks (CNN): Motivation, The Convolution Operation, Pooling, Structured outputs, Kernels. Recurrent and Recursive Nets: Recurrent Neural Networks (RNN), Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, Long-Term Dependencies, Long-Short Term Memory, Gated RNNs.	**9**
Unit 5	Applications: Large scale deep learning, Computer vision, Speech Recognition, Natural Language Processing, Other applications, Deep Learning Tools and Libraries: Caffe, Theano, Keras.	**9**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press.	2006
2	Python Deep Learning, by Valentino Zocca, GianmarioSpacagna, Daniel Slater, and Peter Roelants, Packt Publishing Ltd.	2017
3	Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education.	2004

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY522: Reinforcement Learning	3	1	0	Basic knowledge of Probability, Linear Algebra, Machine Learning

Course Objective: To equip students with the theoretical foundations and practical skills to design, implement, and analyze reinforcement learning algorithms for decision-making in dynamic environments.

Couse Outcome

Course Outcome (CO):

1. Understand the fundamentals of reinforcement learning and Markov Decision Processes
2. Apply dynamic programming and Monte Carlo methods to solve RL problems
3. Implement and evaluate temporal-difference learning algorithms
4. Apply function approximation techniques
5. Explore and identify application which can be solved by RL.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	2		
CO2	2		3
CO3	2		3
CO4	2		3
CO5	2		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Difference between supervised, unsupervised, and RL, Applications of RL (robotics, games, NLP, finance, etc.), Agent, environment, state, action, reward, Markov Decision Processes (MDPs), Goal of RL: maximizing cumulative reward	**8**
Unit 2	**Dynamic Programming:** Bellman Equations, Policy Evaluation, Policy Iteration, Value Iteration, Limitations of Dynamic Programming, Gridworld examples. **Monte Carlo Method:** Monte Carlo prediction, Monte Carlo control, Exploring starts, ε-greedy policy, Off-policy vs On-policy learning	**9**
Unit 3	**Temporal Difference Learning:** TD Prediction (TD(0)), SARSA (On-policy TD control), Q-Learning (Off-policy TD control), n-step TD methods, Eligibility traces and TD(λ)	**9**
Unit 4	**Function Approximation:** Limitations of tabular methods, Linear Function Approximation, Non-linear function approximation (Neural Networks), Stochastic Gradient Descent in RL, Convergence issues **Exploration, Exploitation, and Safety:** Exploration strategies (ε-greedy, Boltzmann, UCB), Intrinsic motivation, Safe exploration, Risk-sensitive RL	**9**
Unit 5	**Multi-Agent RL**: Introduction to multi-agent systems, Cooperative vs Competitive settings, Nash Equilibrium, Communication between agents **Applications of RL**: RL in robotics, games (Atari, Go), NLP, recommendation systems, Imitation Learning, Inverse Reinforcement Learning, Meta-RL, Offline RL, Sim2Real transfer	**9**

Total	42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Reinforcement Learning: An Introduction by Richard S. Sutton & Andrew Barto	2018
2	Deep Reinforcement Learning Hands-On by Maxim Lapan (Packt Publishing)	2020
3	Algorithms for Reinforcement Learning by Csaba Szepesvári	2010

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY524: Cyber Security & Law	3	1	0	-

Course Objective: To understand the basics of cyber security, laws, and related issues. To explain the information on cyber security and understand the issues that are specific to amendment rights.

Couse Outcome

Course Outcome (CO):

1. Identify and analyze intervention strategies for cyber security issues, including redundancy, diversity, autarchy, and global regulation.
2. Examine the risks and legal implications of copyright issues, internet infringement, privacy rights, and related constitutional and federal statutes.
3. Implement and analyze the importance of protocols like HTTP, SMTP, etc.
4. Understand duty of care, criminal liability, procedural issues, and the legal framework surrounding electronic contracts, digital signatures, and civil rights.
5. Assess the ethical implications and societal impacts of cyber security, with a focus on legal

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1		1	2
CO2		1	2
CO3	1	1	2
CO4		1	2
CO5		3	2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	The World Wide Web, Web Centric Business, E Business Architecture, Models of E Business, E Commerce, Threats to virtual world. Cyber Crimes& social media, Cyber Squatting, Cyber Espionage, Cyber Warfare, Cyber Terrorism	**7**
Unit 2	Computer ethics, moral and legal issues, descriptive and normative claims, Professional Ethics, code of ethics and professional conduct. Privacy, Computers and privacy issue.	**6**
Unit 3	Web Servers and Browsers, HTTP, Cookies, Caching, Plug-in, ActiveX, Java, JavaScript, Secure Socket Layer (SSL), Secure Electronic Transaction (SET). E-mail Risks, Spam, E-mail Protocols, Simple Mail Transfer Protocol (SMTP), Post office Protocol (POP), Internet Access Message protocol (ICMP). Secured Mail Protocols	**10**
Unit 4	Copyrights, Jurisdiction Issues and Copyright Infringement, Multimedia and Copyright issues, WIPO, Intellectual Property Rights, Understanding Patents, Understanding Trademarks, Trademarks in Internet, Domain name registration, Software Piracy, Legal Issues in Cyber Contracts, Authorship, Document Forgery.	**8**
Unit 5	Indian IT ACT, Adjudication under Indian IT ACT, IT Service Management Concept, IT Audit standards, System audit, Information security audit, ISMS, SoA (Statement of Applicability), BCP (Business Continuity Plan), DR (Disaster Recovery), RA (Risk Analysis/Assessment).	**11**

Total	42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Jonathan Rosenoer. "Cyber Law: The law of the Internet", Springer-Verlag.	1997
2	Mark F Grady. FransescoParisi, "The Law and Economics of Cyber Security", Cambridge University Press, 2006	2006

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY526: Smart Sensing for Internet of Things	3	0	2	-

Course Objective: Deepen the understanding of IoT network models and applications for novel system design.

Couse Outcome

Course Outcome (CO):

1. To understand the various models, designs and applications of IoT.
2. To discuss similarities and differences between IoT, M2M, and SDN. To understand IoT platform and design Methodology.
3. To be able to program using Python packages for system design of IoT.
4. To perform data analytics on IoT data using Hadoop, Apache and Map reduce techniques.
5. To explore ethical aspects of implementation and application of IoT.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1			
CO2		1	
CO3	2		
CO4	3	1	
CO5	3		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	Introduction to Internet of Things, Definitions and Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols.	**8**
Unit 2	IoT and M2M, Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization, IoT Platform Design Methodology, Introduction, IoT Design Methodology.	**8**
Unit 3	IoT System Logocal Design Using Python, Introduction, Installing Python, Python Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date Time applications, Classes, Python Packages of Interest for IoT.IoT Physical Devices and End Points.	**9**
Unit 4	Data Analytics for IoT; Introduction AppacheHadoop, using HadoopMapReduce for Batch Data Analysis, Apache oozie, Apache Spark, Apache Storm, using Apache Storm for Real-time Data Analysis.	**9**
Unit 5	Ethics: Characterizing the IoT, Privacy, Control, Distributing Control and Crowd Sourcing.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Raj Kamal ,"INTERNET OF THINGS" , McGraw-Hill	2022
2	Timothy Chou, "Precision - Internet of Things", McGraw-Hill.	2017
3	Rajkumar Buyya, Amir Vahid Dastjerdi **,** "Internet of Things Principles and Paradigms", Morgan Kaufmann	2016

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY560: Pattern Analysis	3	1	0	Basic course on probability and statistics

Course Objective: To familiarize the student with the basic concepts and methodologies for pattern analysis and explore applications in real world.

Couse Outcome

Course Outcome (CO):

1. To describe Pattern recognition fundamentals.
2. To compute object, boundary and regional descriptors.
3. To estimate Maximum-likelihood and Bayesian parameter estimation and apply Bayesian decision theory, Minimum-error-rate classification and Discriminant functions
4. To investigate unsupervised classification using different similarity and dissimilarity measures.
5. To understand the mechanism behind and evaluate the predictive performance of an artificial neural network.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2	2		2
CO3	2		2
CO4	2		2
CO5	2		2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	Introduction to Pattern Analysis, Types of patterns, Feature, feature vectors, feature space and classifiers. Pattern recognition systems and its applications such as web-based patterns.	**6**
Unit 2	Object Representation: Chain codes, Polygon Approximations, Signatures, Boundary segments, skeletons. Boundary Descriptors: Fourier Descriptor and Statistical Moments. Regional Descriptors: Topological descriptor, texture, moments of 2-D functions.	**8**
Unit 3	Maximum-likelihood and Bayesian parameter estimation: Maximum Likelihood estimation: Gaussian case, Maximum a Posteriori estimation, Bayesian estimation. Bayesian decision theory: Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and Discriminant functions, Discrete features, Missing and noisy features.	**10**
Unit 4	Clustering, fundamentals of clustering, similarity/ dissimilarity, measures, clustering criteria, different distance functions: Bhattacharya Distance, scatter matrices, minimum cluster distance criteria, K-mean algorithm, K-medoids, DBSCAN, dataset visualization, unique clustering, no existence of clusters.	**10**

Unit 5	Neural networks as a feature extractor and classifier, single layer perceptron, multi-layer perceptron, training set, test set, generalization, normalization, and evaluation, evaluation Parameters-Accuracy, confusion matrix, Precision, Recall, ROC, F-measure, specificity, sensitivity.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Richard O. Duda, Peter E. Hart, David G. Stork , "Pattern Classification", IInd edition, Wiley	2007
2	Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer.	2006
3	S.Theodoridis, K. Koutroumbas, "Pattern Recognition", IInd Edition, Elsevier.	2008
4	Rafael C. Gonzalez, Richard Eugene Woods "Digital Image Processing" 3rd Edition, Pearson.	2008

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY562: FoG and Edge Computing	3	1	0	Computer Networks

Course Objective: To introduce Fog and Edge enabling technologies and its opportunities, review underlying technologies, limitations, and challenges along with performance metrics and discuss generic conceptual framework in Edge computing.

Couse Outcome

Course Outcome (CO):

1. Explore technologies behind the communication and management of edge resources.
2. Learn the techniques for storage and computation in fog, edges, 5G and clouds.
3. Implement Internet of Everything (IoE) applications through Fog and edge computing architecture, and use optimization techniques for the same.
4. Analyze the performance and issues of the applications developed using Fog and edge architecture.
5. To explore and identify the applications of FoG and Edge Computing.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1	2		1
CO2	2		2
CO3	2		2
CO4	2		2
CO5	2		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction**: Relevant Technologies - Fog and Edge Computing Completing the Cloud - Hierarchy of Fog and Edge Computing - Business Models – Edge Computing Platforms -Opportunities and Challenges	**8**
Unit 2	**Challenges in Federating Edge Resources:** Introduction - Methodology - Integrated C2F2T Literature by Modeling Technique -Integrated C2F2T Literature by Use - Case Scenarios - Integrated C2F2T Literature by Metrics – Threads - Standards	**8**
Unit 3	**Orchestration of Network Slices in Fog, Edge, and Clouds:** Introduction – Background, Network Slicing in Software-Defined Clouds, Network Slicing Management in Edge and Fog - Internet of Vehicles (IoV): Architecture, Protocols and Seven-layer security model architecture for Internet of Vehicles - IoV: Network Models, Challenges and future aspects	**9**
Unit 4	**Optimization Problems in Fog and Edge Computing:** Preliminaries - The Case for Optimization in Fog Computing-Formal Modeling Framework for Fog Computing – Metrics - Further Quality Attributes - Optimization Opportunities along the Fog Architecture - Optimization Opportunities along the Service Life Cycle - Toward a Taxonomy of Optimization Problems in Fog Computing	**9**
Unit 5	**Applications of Fog and Edge Computing:** Exploiting Fog Computing in Health Monitoring-Smart Surveillance Video Stream Processing at the Edge for Real - Time Human Objects Tracking-Fog Computing Model for Evolving Smart Transportation Applications - Testing Perspectives of Fog - Based IoT Applications - Legal Aspects of Operating IoT Applications in the Fog	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Fog and Edge Computing: Principles and Paradigms, 1st edition, John Wiley & Sons, USA.	2018
2	"Fog Computing", Assad Abbas, Samee U. Khan, Albert Y. Zomaya, Wiley.	2020
3	"IoT and Edge Computing for Architects - Second Edition", Perry Lea, Packt Publishing	2020
4	"Fog/Edge Computing For Security, Privacy, and Applications", Wei Chang (Editor), Jie Wu (Editor).	2021

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY564: Advanced Algorithms and Analysis	3	1	0	C/C++ Programming, Foundations of Algorithms and Data Structures

Course Objective: To provide students with a deep understanding of algorithm design techniques, advanced algorithms, and their practical applications.

Couse Outcome

Course Outcome (CO):

1. To implement iterative and recursive algorithms, analysis of advanced tree structures for efficient data manipulation and search.
2. To comprehend and apply randomized algorithms, and game theoretic techniques in algorithm design.
3. To perform amortized analysis on greedy algorithms, and implement graph algorithms for various problems.
4. To analyze sorting algorithms, understand lower bounds, medians, and order statistics, and perform complexity analysis on sorting and searching algorithms.
5. To implement and analyze matrix operations and string matching algorithms for solving problems efficiently.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	2	2	3
CO2	2	1	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Algorithm Design Techniques:** Iterative and Recursive techniques: their correctness and analysis. Divide and Conquer: Application to Sorting and Searching (review of binary search), merge sort, quick sort, their correctness and analysis. Recapitulation of order of growth & growth of functions, recurrences, probability distributions, Average case analysis of algorithms	**8**
Unit 2	**Advanced Topics in Algorithms Design** Randomized Algorithms: Basic concepts, analysis, applications in sorting and searching. Game Theoretic Techniques: Zero-sum games, Nash equilibrium, applications in algorithm design.	**7**
Unit 3	**Dynamic Programming and Greedy Algorithms** Introduction to Dynamic Programming: Application to various problems (for reference; Weighted Interval Scheduling, Sequence Alignment, Knapsack), their correctness and analysis.	**11**

	Introduction to Greedy Algorithms - Amortized Analysis. Graph Algorithms: Maximum Flow algorithms, Application to various problems, their correctness and analysis	
Unit 4	**Sorting and Searching:** Heapsort, Lower Bounds using decision trees, sorting in Linear Time - Bucket Sort, Radix Sort and Count Sort, Medians & Order Statistics, complexity analysis and their correctness.	**8**
Unit 5	**Matrix Operations**: Strassen's Matrix Multiplication, inverting matrices, Solving system of linear Equations **String Matching:** Naive String Matching, Rabin-Karp algorithm, matching with finite Automata, Knuth- Morris-Pratt algorithm, Z Algorithm	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	"Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 3rd Edition	2009
2	"Algorithms" by Robert Sedgewick and Kevin Wayne, 4th Edition.	2011
3	"Algorithm Design" by Jon Kleinberg and Éva Tardos, 1st Edition.	2005
4	"Advanced Data Structures" by Peter Brass,1st Edition.	2008
5	"The Algorithm Design Manual" by Steven S. Skiena, Springer, 2nd Edition,	2008

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY566: Quantum Computing	3	1	0	Linear Algebra & Probability

Course Objective: to provide a self-contained, comprehensive introduction to quantum computing, focusing on the design and analysis of quantum algorithms, as well as covering topics in quantum information and quantum cryptography, such as: quantum teleportation, quantum money, and post-quantum cryptography.

Couse Outcome

Course Outcome (CO):

1. Understand the quantum computing paradigm.
2. State the four postulates of quantum mechanics and their application to computation
3. Design and analyse quantum algorithms. - Grasp the notions of quantum states, unitary evolution, measurements, and composite systems.
4. Understand the implications of quantum computing on cryptography and security.
5. Analyse fundamental quantum algorithms: - Shor's algorithm. - Grover's search. - The Berstein-Vazirani algorithm. - Simon's problem. - The Deutsch-Jozsa paradigm.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	1		2
CO2	1	2	3
CO3	2	2	3
CO4	2	2	3
CO5	3	2	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to Quantum computing**: motivation, foundations, and prominent applications. Review of linear algebra in the context of quantum information, Dirac's bracket notation, limitation of classical algorithms. The four postulates of quantum mechanics, qubits, quantum gates and circuits.	**9**
Unit 2	**Basic quantum algorithms I**- Deutsch's algorithm, analysing quantum algorithms, and implementing quantum circuits via QISKIT.	**6**
Unit 3	**Basic quantum algorithms II** — Simon's problem and the Bernstein -V-azirani algorithm. Grover's quantum search algorithm, the BBBV Theorem, and applications of Grover's algorithm. RSA, and Shor's integer factorisation algorithm.	**12**
Unit 4	**Introduction to quantum cryptography**-post-quantum security, quantum key distribution.	**7**
Unit 5	**Introduction to quantum information:** superdense coding, nocloning theorem, quantum teleportation **Applications**: quantum money, the Elitzur-Vaidman bomb.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Nielse ,“Quantum Computation And Quantum Information” , Cambridge University Press	2013
2	Chuck Easttom, “QUANTUM COMPUTING FUNDAMENTALS”, Pearson Education.	2022
3	Parag K. Lala, “QUANTUM COMPUTING”, McGraw Hill	2020
4	Daniel J. Bernstein (Editor), Erik Dahmen (Editor), Johannes Buchmann (Editor), "Post-Quantum Cryptography", Springer-Verlag Berlin and Heidelberg Gmb	2010

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY568: Bioinformatics	3	1	0	Database Management Systems

Course Objective: Understanding and application of biological databases for different applications

Couse Outcome

Course Outcome (CO):

1. To understand basics of biological databases.
2. To learn information retrieval from biological databases.
3. To experiment with different statistical methods on biological databases.
4. To study chromosome and genome mapping.
5. To apply predictive methods for DNA sequencing and protein mapping.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			1
CO2	2		1
CO3	2	1	3
CO4	2	2	3
CO5	2	2	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**The Biologist & Internet**: Internet basics, FTP, World Wide Web, and Introduction to Primary & Secondary database, GenBank, GCG, and ACDEB. Structure Databases: Introduction to structures, PDB, MMDB, Structure file formats, Visualizing structural information, Database structure viewers.	**9**
Unit 2	**Information Retrieval from Biological Databases & submission of DNA Sequences to the Databases:** Retrieving database entries, Integrated information retrieval: The ENTREZ system, sequence databases beyond NCBI, Medical Databases.	**8**
Unit 3	**Sequence Alignment and Database Searching:** Introduction, Evolutionary basis of sequence alignment, Optimal alignment methods, Substitution scores & gap penalties, Statistical significance of alignments, Database similarity searching.	**8**
Unit 4	**Multiple Sequence Alignment & Genome Mapping:** Progressive alignment methods, Motifs and patterns, Probe, Presentation methods, Abscript; Different types of maps: physical, genetical, etc. Synteny, Human genome project, Application of genome mapping, Chromosome maps.	**9**
Unit 5	**Predictive Methods Using Nucleotide & protein Sequences:** Framework, marking repetitive DNA, Database search, Codon bias detection, detecting function sites in the DM, Protein identity based on composition.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/

		Reprint
1	A.D. Baxevanis and B.F.F. Ouellette, Bioinformatics: A practical guide to the analysis of genes and proteins, John Wiley and Sons. ISBN 0-471-38391-0.	2001
2	Rastogi, S.C., Mendiratta, N. and Rastogi, Bioinformatics: Concepts, Skills &Applications, CBS Publishers &Distributors, New Delhi. ISBN 13: 9788120330627.	2004
3	Dix A., Finlay J.,Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education.	2005

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY530: Generative AI	3	0	2	-

Course Objective: To learn the fundamental concepts of Generative AI technologies for various applications

Couse Outcome

Course Outcome (CO):

1. Understand the fundamental concepts of transformers, diffusion models, and their applications in vision and language tasks.
2. Analyze and differentiate between various transformer architectures used in language and vision, including GPT, BERT, ViT, and CLIP.
3. Implement and fine-tune multi-modal and generative foundation models using efficient training and inference techniques.
4. Evaluate foundation models using standard benchmarks and address issues related to hallucinations, bias, fairness, privacy, and prompt engineering.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to Foundation Models:** **Transformers & Attention:** Introduction to Transformers, Self-Attention, Cross-Attention, Perceiver: Arbitrary IO with transformers, Self Attention & Non-Parametric Transformers **Diffusion:** Sampling, Diffusion Models, Latent Diffusion Models (LDM) Applications: LLMs, LVMs and Applications in Vision	**14**
Unit 2	**Foundation Model Architectures:** Foundation Model Architectures: Transformers in Language including GPT, BERT, RetNet, State Space Models Transformers in Vision: ViT, MLP-Mixer, Conformer, Vision-Language (VL) models, CLIP Architectures: Dual-Encoder, Fusion, Encoder-Decoder, Adapted LLM, Unified Architectures	**14**
Unit 3	**Multi-Modal & Generative Foundation Models:** Training & Inference: Training Objectives, Contrastive Learning, Efficient Inference Techniques, Pre- training, Fine-tuning & Parameter Efficient Fine-tuning (LoRA, QLoRa), Flash Attention, Retrieval Augmented Generation (RAG)	**8**
Unit 4	**Evaluation & Benchmarking:** Evaluation Protocols and Standard Benchmarks, Hallucinations, Bias & Fairness, Privacy, Memorization, Machine Unlearning, Prompt Engineering	**6**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	"Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models" Joseph Babcock and Raghav Bali, packt Publishing	2021
2	"Learn Python Generative AI: Journey from autoencoders to transformers to large language models", Zonunfeli Ralte and Indrajit Kar, Bpb Publication.	2024
3	"Generative Deep Learning" By David Foster & Karl Friston, O'Reilly.	2023

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY532: Data Engineering & Analytics	3	0	2	Probability, Statistics, Linear Algebra

Course Objective: 1. To familiarize with the concepts of data mining, data storage, data pipeline and data integration. 2.To analyze data using classification, clustering, feature selection, association rule mining and itemset mining.
3. To understand and explore data warehousing architectures and data lakes.

Couse Outcome

Course Outcome (CO):

1. Ability to understand and describe data mining, data storage, data pipeline and data integration concepts.
2. Ability to understand and implement classification and clustering algorithms for analyzing linearly and non-linearly separable data.
3. Ability to understand and implement feature selection algorithms for data reduction.
4. Ability to understand and explore patterns and dependencies in data using association-rule mining and itemset-mining.
5 Ability to understand, explore and describe data warehousing architectures and data lakes.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			2
CO2	2		2
CO3	2		2
CO4	2		2
CO5	2		2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to data engineering:** Storing data, Data loading, Data transformation, Data structures, SQL and NoSQL databases, Database normalization, Data cubes, Snowflake scheme, Data warehouses, Data lakes, Data Marts, Metadata in Data Warehouse, Data pipeline, Data integration-Extract, Transform, and Load (ETL) processes for integrating data from multiple sources.	**10**
Unit 2	**Advanced data analytics and machine learning:** Cluster Analysis, Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods. Classification techniques for linearly separable and non-linearly separable data- Linear Discriminant Analysis and Support Vector Machine. Feature Ranking and Feature Selection Algorithms. Associations and correlations-basic concepts, efficient and scalable frequent item sets mining methods, mining various kinds of association rules, constraint-based association mining.	**12**
Unit 3	**Data warehousing**: Planning Your Data Warehouse, The Data Warehouse Project, Architectural Components: Understanding Data Warehouse Architecture, Infrastructure Supporting Architecture, Collection of Tools. Indexing the data warehouse, performance enhancement techniques.	**10**
Unit 4	**Data design and data preparation**: From Requirements to Data Design, The STAR Schema, STAR Schema Keys, Advantages of the STAR Schema. Data modeling for data warehouses. Scalable data engineering solutions - handling	**10**

	massive datasets. Online Analytical Processing models, Online Transaction Processing models. .	
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei, 3rd ed., *Morgan Kaufmann*	2022
2	Mining Introductory and Advanced Topics, M.H. Dunham, Pearson Education.	2002
3	Data mining, Pieter Adriaans, Pearson Education.	1996
4	Data warehousing in the real world for building decision support systems, Sam Anahory, Pearson Education.	1997
5	The Data Warehouse Lifecycle toolkit, Ralph Kimball, John Wiley.	1996
6	Fundamentals of database systems, Ramez Elmasri, Pearson Education.	2000
7	Oracle8 data warehousing, Michael Corey, Tata McGraw Hill.	1998
8	Data Warehousing Fundamentals, Paulraj Ponniah, John Wiley.	2001

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY534: Multimodal Computing and Application	3	1	0	Programming and Mathematics

Course Objective: To equip students with the knowledge and skills to design, develop, and evaluate intelligent systems that integrate and process multiple data modalities such as text, images, audio, video, and sensor data for real-world applications.

Couse Outcome

Course Outcome (CO):

1. Explain the fundamental concepts, architectures, and challenges of multimodal computing systems.
2. Analyze and preprocess multimodal data from sources such as text, images, audio, video, and sensors.
3. Apply machine learning and deep learning techniques for multimodal representation learning and data fusion..
4. Design and develop multimodal applications for tasks such as classification, retrieval, recognition, and decision-making.
5. Evaluate the performance, scalability, and ethical implications of multimodal computing solutions in real-world scenarios.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	1		2
CO2	1	2	2
CO3	2	2	2
CO4	2	2	2
CO5	2	2	2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to Multimodal Computing:** Fundamentals of multimodal computing, Types of modalities: text, image, audio, video, sensor data Multimodal data characteristics and challenges, Multimodal interaction and human-computer interfaces, Applications of multimodal systems in healthcare, education, smart cities, and industry.	**6**
Unit 2	**Multimodal Data Processing and Feature Extraction:** Data acquisition and preprocessing techniques, Text processing and feature extraction Image and video feature extraction, Audio and speech feature extraction, Data representation and embedding techniques, Feature normalization and dimensionality reduction.	**10**
Unit 3	**Multimodal Learning and Data Fusion:** Introduction to multimodal machine learning , Feature-level, decision-level, and hybrid fusion methods, Representation learning for multimodal data , Deep learning architectures for multimodal systems , Attention mechanisms and transformer-based multimodal models , Cross-modal learning and alignment	**8**
Unit 4	**Multimodal Applications:** Multimodal classification and recognition , Vision-language systems , Speech and language integration , Multimodal	**10**

	information retrieval and recommendation systems **,** Human activity recognition and emotion detection **,** Intelligent assistants and conversational AI .	
Unit 5	**Advanced Topics and Case Studies:Generative** AI and foundation models for multimodal applications , Multimodal analytics in IoT and cyber-physical systems, Performance evaluation metrics and benchmarking , Privacy, security, fairness, and ethical considerations **,** .	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Deep Learning — Goodfellow, Bengio & Courville	2016
2	Computer Vision: Algorithms and Applications (2nd Ed.) — Richard Szeliski	2022
3	Speech and Language Processing (3rd Ed. Draft) — Jurafsky & Martin	2023

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY536: Digital and Cyber Forensics	3	0	2	-

Course Objective: : Upon completion, students will understand digital forensics principles and real-world crime examples, address challenging aspects like encryption and jurisdiction, and apply investigation processes using various forensic tools in Windows and UNIX environments.

Couse Outcome

Course Outcome (CO):

1. To employ various forensic tools and technologies in practical scenarios, ensuring the integrity and admissibility of digital evidence in legal proceedings.
2. To develop an understanding of various types of computer forensics enabling them to effectively analyze digital evidence from diverse sources.
3. Students will be proficient in conducting live data collection and analysis in Windows environments.
4. Students will be proficient in conducting live data collection and analysis in Unix environments.
5. To demonstrate proficiency in conducting ethical hacking activities, including port scanning and vulnerability assessments using tools.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2	1		2
CO3	1		2
CO4	1		2
CO5	1		2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to Digital forensics**: Digital evidence and investigations, Real life examples of digital crime, Challenging aspects of digital forensics. Introduction to intellectual property rights and professional ethics.	**8**
Unit 2	**Computer crime investigation process**: The Investigation process, preparing a computer investigation. **Overview of Types of computer forensics** i.e. Media Forensics, Network forensics (internet forensics), Machine forensic, Email forensic (e-mail tracing and investigations). Digital forensics of image, audio etc files.	**9**
Unit 3	**Live Data collection and investigating windows environment**: windows Registry analysis, Gathering Tools to create a response toolkit (Built in tools like netstat, cmd.exe, nbtstat, arp, md5sum, regdmpetc and tools available as freeware like Fport , Pslistetc)	**9**
Unit 4	**Live Data collection and investigating UNIX environment** Forensic tools and report generation: Recovery of Deleted files in windows, Analyzing network traffic, sniffers	**8**
Unit 5	**Ethical Hacking**, Hardware forensic tools like Port scanning and vulnerability assessment tools like Nmap, Netscanetc .Password recovery, Mobile forensic tools.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Mandia, Kevin, Prosise, Chris, and Pepe, Matt," Incident Response &Computer Forensics", McGraw-Hill.	2003
2	Beebe, Nicole Lang, and Jan Guynes Clark, "A Hierarchical, Objectives-Based Framework for the Digital Investigations Process	2005
3	Nelson, Bill, Amelia Phillips, Frank Enfinger, and Christopher Steuart," Guide to Computer Forensics and Investigations", Thompson Course Technology, Boston	2006

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY538: Network and Internet of Things	3	1	0	Computer Networks

Course Objective: To learn the fundamental concepts of IoT Networks with its application in various domain.

Couse Outcome

Course Outcome (CO):

1. To understand the fundamentals of Internet of Things.
2. To acquire the knowledge of various technologies which can integrate with IoT.
3. To implement various IoT system using python modules and packages.
4. To understand the data analytics for IoT applications.
5. To implement the security system for latest IoT applications.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2	2		2
CO3	2		2
CO4	2		2
CO5	2		2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	Introduction to Internet of Things: Definitions and Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols.	**8**
Unit 2	IoT and M2M: Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization, IoT Platform Design Methodology, Introduction, IoT Design Methodology.	**9**
Unit 3	IoT System Logocal Design Using Python, Introduction, Installing Python, Python Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date Time applications, Classes, Python Packages of Interest for IoT.IoT Physical Devices and End Points.	**9**
Unit 4	Data Analytics for IoT; Introduction AppacheHadoop, using HadoopMapReduce for Batch Data Analysis, Apache oozie, Apache Spark, Apache Storm, using Apache Storm for Real-time Data Analysis.	**8**
Unit 5	Security: Characterizing the IoT security, Privacy, Control, Distributing Control and Crowd Sourcing.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/

		Reprint
1	Raj Kamal ,“INTERNET OF THINGS” , McGraw-Hill	2022
2	JTimothy Chou, “Precision - Internet of Things”, McGraw-Hill.	2011
3	Rajkumar Buyya, Amir Vahid Dastjerdi , “Internet of Things Principles and Paradigms”, Morgan Kaufmann	2016
4	Dr Kamlesh Lakhwani, Dr Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, "Internet of Things, Principles, Paradigms and Applications in IoT", BPB Publications	2020
5	Raj Kamal, INTERNET OF THINGS (IOT): Architecture and Design Principles, McGraw-Hill	2022

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY580: Soft & Evolutionary Computing	3	0	2	

Course Objective: To provide students exposure to soft computing techniques and optimization background and terminology, genetic operators with various evolutionary strategy for real life problem solving.

Couse Outcome

Course Outcome (CO):

1. To construct a neural network architecture and describe its working, and to distinguish between supervised, unsupervised and reinforcement learning.
2. To execute operations on fuzzy sets and construct fuzzy rules and fuzzy inferencing systems
3. To solve problems involving fuzzy arithmetic and fuzzy numbers.
4. To learn gradient optimization, sampling, linear programming, and combinatorial optimization vocabulary.
5. To study representation, operators, and standard algorithm implementation of Genetic Algorithms (GAs) and evolutionary Computing.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	1		1
CO2	2	1	3
CO3	2	1	3
CO4	2	1	3
CO5	2	1	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Neural Networks:** History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms- Perceptrons, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Applications of Artificial Neural Networks, Radial Basis Function networks	**7**
Unit 2	**Fuzzy Logic:** Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Functions, Fuzzy rule generation and solving, Mamdani, Sugeno and Tsukamoto fuzzy rule systems, Graphical fuzzy inferencing. Operations on Fuzzy Sets: Complement, Intersection, Union, Combinations of Operations, Aggregation Operations, Nonspecificity of Fuzzy Sets, Fuzziness of Fuzzy Sets	**8**
Unit 3	**Fuzzy Arithmetic:** Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Introduction of Neuro-Fuzzy Systems: Architecture of Neuro Fuzzy Networks-ANFIS, MANFIS, CANFIS and other neuro-fuzzy network architectures, Learning mechanisms.	**8**
Unit 4	**Optimization background and terminology:** Gradient optimization methods, sampling methods, linear programming, combinatorial optimization. Evolutionary Biology background and terminology: Genotype and phenotype,	**10**

	unit of selection, genes and traits, chromosomes, alleles, diploid and haploid, fitness, mutation and recombination.	
Unit 5	**Genetic Algorithms:** Representation, operators, and standard algorithm. The building block hypothesis and the schema theorem. **Evolutionary strategies:** Evolution in continuous variables. Evolutionary algorithms as models: Modeling sexual selection, modeling ecosystems, artificial life. **Modularity and regularity in evolution.** The scaling problem and the curse of dimensionality. Evolvability. Module acquisition. Developmental models. Compositional and hierarchical approaches.	**9**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Jang, Jyh-Shing Roger, Chuen-Tsai Sun, and EijiMizutani. "Neuro-fuzzy and soft computing; a computational approach to learning and machine intelligence." PHI, 1997.	1997
2	"An Introduction to Neural Networks", Anderson J.A., PHI, 1995.	1995
3	Neural Networks, Fuzzy Logic and Genetic Algorithms", by S. Rajasekaran& G. A. Vijayalakshmi Pai,: Synthesis & Applications, PHI, 2003.	2003
4	"An Introduction to Genetic Algorithm", Melanie Mitchell, PHI, 1997.	1997
5	Eiben, A.E., Smith, James E, Introduction to Evolutionary Computing, Springer.	2015
6	Naruya Saitou, Introduction to Evolutionary Genomics, Springer	2018
7	Ashish M. Gujarathi, Evolutionary Computation: Techniques and Applications, CRC Press	2016

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY582: Digital Watermarking & Steganalysis	3	0	2	Digital Signal Processing

Course Objective: To equip students with a comprehensive understanding of digital watermarking, steganography, and steganalysis, including theoretical foundations, practical applications, security considerations, and the evaluation and development of robust information hiding systems..

Couse Outcome

Course Outcome (CO):

1. Understand the fundamentals of information hiding, steganography, and digital watermarking

2. Apply various models of watermarking, utilize side information for informed embedding, and develop techniques to ensure robustness against volumetric, temporal, and geometric distortions.

3. Understand security requirements for watermarking, analyze significant known attacks, and implement methods for exact and selective content authentication, localization, and restoration.

4. Conduct steganalysis using significant algorithms, evaluate the effectiveness of steganographic systems.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1			
CO2	2		2
CO3	2		2
CO4	2		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Information Hiding, Steganography, and Watermarking, Importance of Digital Watermarking, Theoretic Foundations of Steganography **Applications and Properties**: Applications of Watermarking, Applications of Steganography, Properties of Watermarking Systems, Evaluating Watermarking Systems, Properties of Steganographic and Steganalysis Systems, Evaluating and Testing Steganographic Systems.	**7**
Unit 2	**Models of Watermarking:** Communication-Based Models of Watermarking, Geometric Models of Watermarking, Modeling Watermark Detection by Correlation, Basic Message Coding: Mapping Messages into Message Vectors, Error Correction Coding, Detecting Multi-symbol Watermarks. **Watermarking with Side Information:** Informed Embedding, Watermarking Using Side Information, Dirty- Paper Codes, Robust Watermarking: Approaches, Robustness to Volumetric Distortions, and Robustness to Temporal and Geometric Distortions.	**8**
Unit 3	**Watermark Security:** Security Requirements, Watermark Security and Cryptography, Some Significant Known Attacks, Content Authentication: Exact Authentication, Selective Authentication, Localization, Restoration.	**8**
Unit 4	**Steganalysis:** Steganalysis Scenarios, Some Significant Steganalysis Algorithms, Case studies.	**10**

Total	42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Ingemar Cox Matthew Miller Jeffrey Bloom Jessica Fridrich Ton Kalker, "Digital Watermarking and Steganography	2007
2	Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Digital Watermarking principles, Morgan Kaufmann	2011

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY584: Ethical Hacking	3	0	2	Digital Signal Processing

Course Objective: This course provides a comprehensive understanding of security principles, ethical hacking concepts, and essential terminologies such as threats, attacks, vulnerabilities, and exploits.

Couse Outcome

Course Outcome (CO):

1. To comprehend the significance of security, ethical hacking concepts, and key terminologies such as threats, attacks, and vulnerabilities.

2. To gain proficiency in various hacking phases including foot printing, scanning, system hacking, and session hijacking.

3. To develop skills to identify buffer overflow vulnerabilities, understand why programs are susceptible, and implement methods to trap and prevent buffer overflow attacks.

4. To acquire expertise in securing web applications, including defense mechanisms against SQL injection, cross-site scripting (XSS), and other common threats, along with knowledge of web application technologies and best practices.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	2		
CO2	3		3
CO3	3		2
CO4	3		2

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Understanding the importance of security, Concept of ethical hacking and essential. Terminologies-Threat, Attack, Vulnerabilities, Target of Evaluation, Exploit. Phases involved in hacking, Foot printing, Scanning, System Hacking, Session Hijacking. Buffer Overflows: Significance of Buffer Overflow Vulnerability, Why Programs/Applications are vulnerable. Reasons for Buffer Overflow Attacks. Methods of ensuring that buffer overflows are trapped, Sniffing	**10**
Unit 2	**SQL Injection:** Attacking SQL Servers, Sniffing, Brute Forcing and finding Application, Configuration Files, Input validation attacks. Preventive Measures. Web Application Threats,	**10**
Unit 3	**Web Application Hacking**, Cross Site Scripting / XSS Flaws / Countermeasures Correct Web Application Set-up. **Web Application Security**: Core Defence Mechanisms. Handling User Access, Authentication, Session Management, Access Control. Web Application Technologies: HTTP Protocol, Requests, Responses and Methods.	**12**
Unit 4	**Attacking Authentication:** Attacking Session Management, Design Flaws in Authentication, Mechanisms Attacking Forgotten Password Functionality, attacking Password change functions. Attacking other users: Reflected XSS Vulnerabilities, Stored XSS	**10**

	Vulnerabilities, DOM-Based, XSS Vulnerabilities, HTTP Header Injection. Countermeasures to XSS.	
Total		**42**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Introduction to Computer Networks and Cybersecurity -- C-H. Wu and J. D. Irwin	2013
2	Cryptography and Network Security: Principles and Practice -- W. Stallings	1998

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY586: Multi-Agent Systems	3	1	0	

Course Objective: Comprehensive understanding of DevOps principles, practices, and tools to streamline software delivery and enhance collaboration between development and operations teams.

Couse Outcome

Course Outcome (CO):
1. To understand the fundamentals of Multi agent systems.
2. To be able utilize a variety of principles of agent design and reasoning.
3. To get learning of agent-oriented methodologies.
4. To learn design of coordination Structures. Social Models for Coordination. Trust and Reputation.
5. To explore Agent-Oriented Design for real world novel applications.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1			
CO2			2
CO3	2		2
CO4	2		2
CO5	3		3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to intelligent agents**. Definition, Architectures interface agents, information agents, heterogeneous Multi-Agent Systems, distributed-intelligent-systems, Communication, Standards, Coordination, Negotiation, Distributed planning. Voting. Auctions. Coalition formation. Application of multi-agent systems to industrial problems.	**9**
Unit 2	**Agent Design**: Reasoning in Agents Definition of Reasoning. Automated Reasoning. Reasoning Paradigms. Symbolic Reasoning Agents. Deductive Reasoning Agents. Agent-Oriented Programming, Practical Reasoning. BDI Agents. BDI Agent Control Loop	**9**
Unit 3	**Agent-Oriented-Methodologies** Current trends in Software engineering. Agent-Oriented Software Engineering. Agent-Oriented Methodologies. The GAIA Methodology. The Prometheus Methodology	**8**
Unit 4	**Social Design**: Coordination and Social Models Coordination in MAS. Coordination Structures. Social Models for Coordination. Trust and Reputation Models. Organizational Models. Institutional Models.	**8**
Unit 5	**Applications of Agent-Oriented Design.** Agent-Oriented Design for 1) Electronic Negotiation Support, 2) Flexible Dynamic Web services, 3) multi-robotic environments. Case studies for the practical assignments.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	1. Michael Wooldridge (John Wiley and Sons), An Introduction to Multiagent Systems, first edition 2002, or second edition, 2009.	2009
2	Luck, M., McBurney, P., Shehory, O., Willmott, S, Agent Technology: Computing as interaction. A Roadmap to Agent Based Computing, Willmott, S., 2005.	2005

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY588: Advanced Operating Systems	3	1	0	Operating Systems

Course Objective: Develop a comprehensive understanding of process synchronization, distributed operating systems, resource management, scheduling, failure recovery, fault tolerance, and security mechanisms in both centralized and distributed computing environments.

Couse Outcome

Course Outcome (CO):

1. Gain proficiency in understanding and resolving synchronization problems in operating systems, including critical section management and deadlock detection, paving the way for advanced system design approaches.
2. Analyze and implement distributed mutual exclusion, deadlock detection, and agreement protocols to address challenges inherent in distributed operating systems architecture and resource management.
3. Develop expertise in distributed scheduling techniques and load balancing algorithms to optimize system performance and resource utilization in distributed computing environments.
4. Acquire knowledge and skills in failure recovery and fault tolerance mechanisms to ensure reliable communication in distributed systems.
5. Develop expertise in cryptographic techniques to enhance robust security in distributed systems, demonstrated through case studies like Kerberos Security.

CO-PO Articulation metrics

	PO1	PO2	PO3
CO1	1		2
CO2			3
CO3	2		3
CO4	1	1	3
CO5	2	1	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Process Synchronization:** Functions of OS, Design Approaches, Advanced OS. Concept of Process, Concurrent Process, The Critical Section Problem, Synchronization Problems. Process Deadlock, Models of Deadlocks, Models of Resources, Graph Theoretical model of System state, Condition of deadlock, Single Unit request, Consumable resources, Reusable resources.	**8**
Unit 2	**Distributed Operating systems:** System architecture types, Distributed OS, issues in distributed OS, Limitations of Distributed Systems, Lamport's logical clock, Vector clocks, Casual ordering of messages, Global State. Distributed Mutual Exclusion, Distributed deadlock detection, Agreement Protocols.	**10**
Unit 3	**Distributed Resource management:** Distributed File System, mechanism of building Distributed file systems, Design issues, Log structured file systems, Distributed shared memory, Algorithms, Memory Coherence, Coherence Protocols, Design Issues. Distributed Scheduling: issues in load balancing, Components of Load Distributing Algorithms, Load Distributing Algorithms.	**8**
Unit 4	**Failure Recovery and Fault Tolerance:** Recovery, checkpointing and recovery, checkpointing for distributed database systems. Atomic actions and	**8**

	Committing, Commit Protocols, Voting Protocols, Failure Resilient Processes, Reliable Communication.	
Unit 5	**Protection and Security:** Resource Security and Protection, Access and control flow, Implementation of Access control matrix, Safety in access Matrix Model, Advanced Models of protection, Cryptography, Conventional cryptography, Modern Cryptography, Private Key Cryptography: DES, Public Key Cryptography, Multiple Encryptions, Authentication in distributed Systems. Case study: The Kerberos Security.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Mukesh Singhal , Niranjan Shivaratri, "ADVANCED CONCEPTS IN OPERATING SYSTEMS", McGraw Hill Education.	2017
2	Andrew S. Tanenbaum, Maarten Van Steen,"Distributed Systems: Principles and Paradigms", Pearson Prantice Hall.	2016

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY542: Generative AI and Agentic AI Systems	2	0	4	Basic knowledge of ML, DL and Python Programming

Course Objective:

To provide students with a comprehensive understanding of generative AI, foundation models, large language models, retrieval-augmented generation, multimodal generative systems, and agentic AI workflows, with emphasis on practical implementation, responsible deployment, evaluation, and safety of generative AI applications.

Course Outcome:

CO1: Explain the fundamental concepts of generative AI, foundation models, large language models, multimodal models, and agentic AI systems.

CO2: Analyze the architecture, inference process, adaptation methods, and limitations of large language models and foundation models.

CO3: Apply prompt engineering, embeddings, vector databases, and retrieval-augmented generation techniques to develop low-compute generative AI applications.

CO4: Design and implement generative AI and agentic AI workflows using APIs, small open-source models, pre-trained models, and tool-based orchestration.

CO5: Evaluate generative AI, RAG, and agentic AI systems with respect to output quality, hallucination, safety, privacy, bias, and responsible deployment.

CO-PO Articulation Metrics

	PO1	PO2	PO3
CO1	1	1	2
CO2	2	1	3
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Foundations of Generative AI and Foundation Models:** Introduction to generative AI; discriminative vs generative modelling; evolution from traditional AI/ML/DL to foundation-model-based AI systems; self-supervised learning, pre-training and transfer learning; concept of foundation models; large-scale data, compute and scaling behaviour; overview of large language models, vision-language models, diffusion models and multimodal foundation models; instruction tuning and alignment: basic concepts; capabilities, limitations and application areas of generative AI; low-compute approaches for using generative AI systems through APIs, pre-trained models	**5**
Unit 2	**Large Language Models:** Architecture, Inference and Adaptation: Transformer architecture recap; tokenization and subword tokenizers; embeddings and positional encoding; self-attention and multi-head attention; encoder-only, encoder-decoder and decoder-only language models; autoregressive language modelling and next-token prediction; pre-training, instruction tuning and	**6**

S. No.	Content	Contact Hours
	supervised fine-tuning: conceptual overview; decoding strategies including greedy decoding, beam search, temperature sampling, top-k and top-p sampling; context window and long-context processing; parameter-efficient adaptation methods including adapters and LoRA; quantization, model compression and efficient inference for low-compute environments; limitations of LLMs including hallucination, context sensitivity and computational cost.	
Unit 3	**Prompting, Embeddings and Retrieval-Augmented Generation:** Prompt engineering principles; zero-shot, few-shot and role-based prompting; prompt templates and structured output generation; reasoning-oriented prompting and limitations of prompting; embeddings for text and documents; semantic similarity and semantic search; vector databases and indexing; document loading, preprocessing and chunking strategies; retrieval pipelines and re-ranking; retrieval-augmented generation; grounding and citation-aware generation; hallucination reduction using retrieval; evaluation of RAG systems including relevance, faithfulness, answer correctness and context utilization; low-compute implementation of RAG using APIs, small embedding models and lightweight vector stores.	**6**
Unit 4	**Multimodal Generative AI and Domain-Specific Foundation Models:** Introduction to multimodal foundation models; vision-language models and image-text representation learning; CLIP-style models; image captioning and visual question answering; diffusion models for text-to-image generation: basic principles; image generation, editing and inpainting: overview; speech-language and document-understanding models; code generation models and software engineering assistants; domain-specific foundation models for healthcare, education, cybersecurity, remote sensing and enterprise applications; practical use of pre-trained and hosted multimodal models in low-compute environments.	**5**
Unit 5	**Agentic AI Systems, Evaluation, Safety and Responsible Deployment:** Concept of AI agents and agentic AI systems; LLM-based agents; reasoning-action loops; planning and task decomposition; tool use and function calling; memory in agentic systems; agentic RAG and workflow orchestration; single-agent and multi-agent workflows; human-in-the-loop systems; evaluation of LLMs, RAG systems and AI agents; hallucination, prompt injection, jailbreaks and data leakage; bias, toxicity, privacy and governance issues; responsible AI principles for generative AI systems; model cards and system documentation; deployment of lightweight generative AI and agentic AI applications using APIs, small models and simple web interfaces.	**6**
Total		**28**

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Jay Alammar and Maarten Grootendorst, Hands-On Large Language Models, O'Reilly Media	2024
2	C3hip Huyen, AI Engineering: Building Applications with Foundation Models, O'Reilly Media	2025
3	Suhas Pai, Designing Large Language Model Applications, O'Reilly Media	2025
4	David Foster, Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, 2nd Edition, O'Reilly Media	2023
5	Ben Auffarth and Leonid Kuligin, Generative AI with LangChain, 2nd Edition, Packt Publishing	2025

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY601: Natural Language Processing	3	1	0	Probability and statistics, Machine learning

Course Objective: 1. To introduce core NLP concepts, including linguistic principles, formal models (regular expressions, finite state automata), and syntactic frameworks such as CFGs, parsing, PCFGs, and ambiguity resolution.
2. To develop an understanding of text representation techniques and classification methods, including preprocessing steps, frequency-based models, and sequence-based deep learning approaches.
3. To familiarize students with advanced NLP techniques such as lexical semantics, language modeling, natural language generation, and modern applications like large language models, machine translation, and question-answering systems

Couse Outcome

Course Outcome (CO):

1. Ability to apply text preprocessing techniques and regular expressions for structured text processing and pattern matching.
2. Ability to represent text using statistical models such as Bag-of-Words and TF-IDF, and apply machine learning methods for text classification.
3. Ability to analyze lexical semantics using word senses and distributed representations, and apply sequence models such as LSTM and Transformer architectures.
4. Ability to perform syntactic analysis using Context-Free Grammars (CFGs), syntactic parsing, Probabilistic CFGs (PCFGs), and ambiguity resolution techniques.
5. Ability to design and implement language models and neural text generation systems using encoder–decoder architectures

CO-PO Articulation metric

	PO1	PO2	PO3
CO1	1		
CO2	2		2
CO3	2		2
CO4	2		2
CO5	2		1

Syllabus:

S. No.	Content	Contact Hours
UNIT 1	**Introduction to NLP:** Language as a computational problem, linguistic levels (morphology, syntax, semantics, pragmatics, discourse), and ambiguity in language. Text processing fundamentals: Regular Expressions and Finite State Automata for pattern modeling. Overview of NLP pipeline and applications.	**6**
UNIT 2	**Text Representation and Machine Learning for NLP:** Text preprocessing: Tokenization, normalization, stemming, lemmatization. Feature engineering: One-hot encoding, Bag-of-Words, Term Frequency (TF), TF-IDF. Text classification using classical machine learning models. Introduction to distributed representations: Word embeddings (Word2Vec,	**8**

	GloVe concepts).	
UNIT 3	**Sequence Modeling and Deep Learning for NLP:** Neural representations of text: Contextual embeddings. Sequence models: Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM). Transformer architecture: Self-attention mechanism and encoder representations. Applications in sequence labeling and classification tasks.	**6**
UNIT 4	**Syntax and Lexical Semantics:** Syntax: Context-Free Grammars (CFG), syntactic parsing, Probabilistic CFGs (PCFGs), and ambiguity resolution. Part-of-Speech tagging and probabilistic sequence models. Lexical semantics: Word senses, WordNet, synsets, hypernyms, hyponyms, meronyms, holonyms. Word sense disambiguation, semantic similarity, and semantic role labeling.	**8**
UNIT 5	**Language Modeling and Natural Language Generation:** N-gram language models and probabilistic language modeling. Neural language models. Sequence-to-sequence learning: Encoder–decoder architectures using LSTM and Transformers. Attention mechanism and text generation techniques.	**8**
UNIT 6	**Advanced NLP Applications:** Large Language Models (LLMs) and their capabilities. Machine Translation systems. Question Answering systems. Text summarization techniques. Information Retrieval and Man–Machine Interfaces. Overview of real-world NLP systems and evaluation considerations.	**6**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	D. Jurafsky, J. H. Martin, Speech and Language Processing, 2/e, Pearson Education.	2013
2	James Allen, Natural Language Understanding, 2/e, Pearson Education.	2003
3	S. Bird, E. Klein, E. Loper, "Natural Language Processing with Python", O'Reilly.	2009
4	Manning and Schutze, "Foundation of Statistical Natural Language Processing", MIT press.	1999
5	U. Kamath, J. Liu, J. Whitaker, "Deep learning for NLP and speech recognition", Springer.	2019
6	D. Rothman, "Transformers for Natural Language Processing", Packt publishing.	2021

Course Title	Course Structure			Pre-Requisite
	L	T	P	
OIT601: Quantum Computing and Applications	3	1	0	Linear Algebra & Probability

Course Objective: to provide a self-contained, comprehensive introduction to quantum computing, focusing on the design and analysis of quantum algorithms, as well as covering topics in quantum information and quantum cryptography, such as: quantum teleportation, quantum money, and post-quantum cryptography.

Couse Outcome

Course Outcome (CO):

1. Understand the quantum computing paradigm.
2. State the four postulates of quantum mechanics and their application to computation: - Design and analyse quantum algorithms. - Grasp the notions of quantum states, unitary evolution, measurements, and composite systems.
3. Understand the implications of quantum computing on cryptography and security.
4. Analyse fundamental quantum algorithms: - Shor's algorithm. - Grover's search. - The Berstein-Vazirani algorithm. - Simon's problem. - The Deutsch-Jozsa paradigm.

CO-PO Articulation metric

	PO1	PO2	PO3
CO1	1		2
CO2	1	2	3
CO3	2	2	3
CO4	2	2	3
CO5	3	2	3

Syllabus:

S. No.	Content	Contact Hours
Unit 1	**Introduction to Quantum computing:** motivation, foundations, and prominent applications. Review of linear algebra in the context of quantum information, Dirac's bracket notation, limitation of classical algorithms. The four postulates of quantum mechanics, qubits, quantum gates and circuits.	**9**
Unit 2	**Basic quantum algorithms: I** — Deutsch's algorithm, analysing quantum algorithms, and implementing quantum circuits via QISKIT.	**6**
Unit 3	**Basic quantum algorithms II** — Simon's problem and the Bernstein -V-azirani algorithm. Grover's quantum search algorithm, the BBBV Theorem, and applications of Grover's algorithm. RSA, and Shor's integer factorisation algorithm.	**12**
Unit 4	**Introduction to quantum cryptography**: What is Quantum Cryptography? post-quantum security, quantum key distribution.	**7**
Unit 5	**Introduction to quantum information** superdense coding, no cloning theorem, quantum teleportation **Applications of Quantum Computing**: quantum money, the Elitzur-Vaidman bomb, etc.	**8**
Total		42

Books:

S. No.	Name of Books/Authors/ Publisher	Year of Publication/ Reprint
1	Nielse ,"Quantum Computation and Quantum Information", Cambridge University Press	2013
2	Chuck Easttom, "QUANTUM COMPUTING FUNDAMENTALS", Pearson Education.	2022
3	Parag K. Lala, "QUANTUM COMPUTING", McGraw Hill	2020
4	Daniel J. Bernstein (Editor), Erik Dahmen (Editor), Johannes Buchmann (Editor), "Post-Quantum Cryptography", Springer-Verlag Berlin and Heidelberg Gmb	2010