Syllabus

B. Tech Computer Engineering
(Last Year Semester VII and VIII)

From
Academic Year 2023-24
(Revision-1)

(Approved in Academic Council meeting dated)

K. J. Somaiya College of Engineering, Mumbai-77

(A Constituent College of Somaiya Vidyavihar University)

Preamble

KJSCE as a constituent college of Somaiya Vidyavihar University has the academic flexibility to develop and implement its own curriculum *KJSCE-SVU-2020* with features such as inclusion of choice based Open Elective Courses, Audit Courses, Add on Credit Courses, Exposure Courses, etc. Distinct assessment and evaluation methods are also designed based on focus of individual courses. The outcome of this entire exercises; either by way of student placements or the feedback received from all stakeholders is quite encouraging.

At present, Industry is moving towards Industrial revolution 4.0. Knowing very well that every country's education system forms the basis of its progress and the groundwork for its future, we need to be making engineering graduates equipped to take industrial challenges. A common feature in successful education systems is the balance between tradition and the capacity to be flexible and able to adapt to current social trends. To achieve this, Somaiya Vidyavihar University allows for the undergraduate courses to have a focus on the changing industrial scenario.

Our new revision in syllabus *KJSCE-SVU-2020*, introduced from the academic year 2020-21, has been designed based on the revised guidelines from various accrediting bodies.

The said syllabus is a result of expert advice from members of Board of Studies, Faculty of Engineering & Technology and Academic Council; both having due representation from academia as well as appropriate industries. Subsequently faculty members of the college have put in efforts to document it in the form which has been presented here.

Some of the highlights of the *KJSCE-SVU-2020* syllabus are: Introduction of wide choice for branch specific electives, more number of open or interdisciplinary electives, opportunity for internships, etc. Courses like Object Oriented Programming Methodology, Full Stack Development and Digital Design are designed as laboratory oriented courses and pay more attention to hands-on learning.

Focus of academic processes in KJSCE is such that, by the time student completes the requirements of the degree, he/ she will be able to acquire attributes required for profession as an engineer. Outcomes are defined to acquire these attributes which lead to development of curriculum, pedagogy and assessment tools. These tools need to be updated based on experiences of teacher and learner. Hence teaching -learning -evaluation paradigm is going to be a mix of traditional as well as use of ICT tools. Role of the faculty member changes from tutor to trainer / instructor/ facilitator / mentor based on the outcomes targeted.

For measuring learning outcomes of students, traditional methods like tests, laboratory work and End Semester Examinations (ESE) are implemented. Continuous Assessment (CA) is carried out through tests and internal assessment (IA) like quizzes, case studies, mini projects etc. These IA tools enable the students to develop competencies through solutions discussed, improvisations suggested, feedbacks given by faculty members. Through these assessment methods students get opportunity for reading research papers, presenting ideas and working in a team.

Since the assessments are distributed throughout the term the learning process is continuously monitored and graded.

The Department of Computer Engineering courses focus on thrust areas of Department. These areas are Intelligent System and Data Processing, Network System and Security, Image Analysis and Interpretation and System & Software Engineering.

College promotes co-curricular, extra-curricular activities as well as sports; making life outside classroom exciting and rewarding. What makes these activities very effective is the fact that these do not focus only on winning trophies but try to nurture generic skills such as leadership, effective communication, teamwork etc. which are essential skills for a bright professional career.

Along with my colleagues, I welcome you to Department of Computer Engineering and look forward to lead you towards professional career.

Dr. Prasanna Shete
Head
Department of Computer Engineering

Dr. Shubha Pandit
Principal and Dean
Faculty of Engineering and Technology

Vision

To become a center of excellence in discipline of Computer Engineering for developing technically adept professionals with ethical and leadership qualities in service of society.

Mission

- Provide sound technical foundation in Computer Engineering through comprehensive curriculum and application oriented learning.
- Provide ambience for professional growth and lifelong learning for adapting to challenges in rapidly changing technology
- Inculcate social and ethical values and leadership qualities

Program Educational Outcomes (PEO)

A graduate of Computer Engineering will

PEO1. Solve problems in diverse fields using knowledge of Computer Engineering.

PEO2. Excel in professional career, exhibit leadership qualities with ethics &soft skills.

PEO3. Pursue higher education, research or entrepreneurship, engage in professional development, adapt to emerging technologies.

Program Outcomes (PO)

After successful completion of the program Computer Engineering Graduate will be able to:

PO1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, cultural, environmental, health, safety and legal issues relevant to the professional engineering practice; understanding the need of sustainable development

PO7. **Multidisciplinary Competence:** Recognize/ study/ analyze/ provide solutions to real-life

problems of multidisciplinary nature from diverse fields

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

PSO1: Design, construct and implement hardware and software based modern Computing / Information systems with varying complexities

PSO2: Demonstrate competence in designing, implementation and maintenance of computer based applications, computer-controlled equipment and networks of intelligent devices.

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Acronym for category of courses		Acronyms used in syllabus document	
Acronym	**Definition**	**Acronym**	**Definition**
BS	Basic Science Courses	**CA**	Continuous Assessment
ES	Engineering Science	**ESE**	End Semester Exam
HS	Humanities and Social Sciences including Management Courses	**IA**	Internal Assessment
PC	Professional Core Courses	**O**	Oral
PE	Professional Elective courses	**P**	Practical
OE	Open Elective Courses	**P&O**	Practical and Oral
LC	Laboratory Courses	**TH**	Theory
PR	Project	**TUT**	Tutorial
AC	Audit Course	**TW**	Term work
AOCC	Add on Credit Course	**ISE**	In- Semester Examination
AOAC	Add on Audit Course	**CO**	Course Outcome
AVAC	Add on Value Audit Course	**PO**	Program Outcome
EX	Exposure Course	**PSO**	Program specific Outcome
I	Interdisciplinary courses		

Acronyms used for type of Course

Acronym used	Definition
C	Core Course
E	Elective Course
O	Open Elective Technical
H	Open Elective Humanities/Management/SWAYAM-NPTEL
P	Project
L	Laboratory Course
T	Tutorial
X	Exposure course
A	Audit course

Acronyms used in Eight Digit Course code e.g. 116U06C101

Acronym Serially as per code	Definition
1	SVU 2000 First revision
16	College code
U	Alphabet code for type of programme
06	Programme code
C	Type of course
1	Semester I – semester number
01	First course of semester – course serial number It will be XX for the elective/choice based courses

SVU_LY_2020
Semester VII - Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH	Total (Hrs.)	Credits Assigned	Total credits	Course Category
		TH – P- TUT		TH-P-TUT		
116U01C701	Software Architecture and Design Thinking	3- 0- 0	3	3-0-0	3	PC
116U01E73X	Departmental Elective-III	3-0- 0	3	3-0-0	3	PE
116U01E74X	Departmental Elective-IV	3-0-0	3	3-0-0	3	PE
116U06O7xx	OE Technical	3-0-0	3	2-0-0	2	OE
116U01L701	Software Architecture and Design Thinking Lab	0-2- 0	2	0-1-0	1	PC
116U01L73X	Departmental Elective-III Lab	0-2-0	2	0-1-0	1	PE
116U01L74X	Departmental Elective-IV Lab	0-2-0	2	0-1-0	1	PE
116U01P701	Project -1	0-8-0	8	0-4-0	4	PR
116U01A701	MNCC	1-0-0	1	0-0-0	0	MNCC
	Total	**13-14-0**	**27**	**11-7-0**	**18**	

SVU_LY_2020
Semester VII-Examination Scheme

Course Code	Course Name	Examination Scheme							
		Theory Marks				TW	Oral	Pract. and Oral	Total
		Continuous Assessment (CA)			End Sem. Exam				
		ISE	IA	Total					
116U01C701	Software Architecture and Design Thinking	30	20	50	50	--	--	--	100
116U01E73X	Departmental Elective-III	30	20	50	50	--	--	--	100
116U01E74X	Departmental Elective-IV	30	20	50	50	--	--	--	100
116U06O7xx	OE Technical	30	20	50	--	--	--	--	50
116U01L701	Software Architecture and Design Thinking Lab	--	--	--	--	25	25	--	50
116U01L73X	Departmental Elective-III Lab	--	--	--	--	25	25	--	50
116U01L74X	Departmental Elective-IV Lab	--	--	--	--	25	25	--	50
116U01P701	Project -1	--	--	--	--	25	25	--	50
	Total	**120**	**80**	**200**	**150**	**100**	**100**	**--**	**550**

Departmental Elective - III for VII Semester

Sr. No.	Course Code	Name of Elective	Remarks
1	116U01E731	Big Data Analytics	Not available to students with Honours in Data Science and Analytics
2	116U01E732	Cyber Security, Forensics and Cyber Law	Not available to Honours in Cyber Security and Forensics
3	116U01E733	Geographic Information System and Spatial Computing	Not available to Honours in Geospatial Computing
4	116U01E734	User Experience Design	
5	116U01E735	Reinforcement Learning	
6	116U01E736	Secure Coding	Not available to Honours in Cyber Security and Forensics
7	116U01E737	Adv. Cloud Computing	With pre-requisite of previous CC course

Departmental Elective - IV for VII Semester

Sr. No.	Course Code	Name of Elective	Remarks
1	116U01E741	Data Science	Not available to students with Honours in Data Science and Analytics
2	116U01E742	Block Chain Technology	Not available to Honours in Cyber Security and Forensics
3	116U01E743	Computer Vision	
4	116U01E744	Computer Simulation and Modelling	
5	116U01E745	C# Programming and. Net Technology	
6	116U01E746	Agile Project Management	

Open Electives Technical for VII Semester

Sr. No.	Course Code	Name of the Elective
1	116U06O701	Genetics Algorithm and Applications
2	116U06O702	Reinforcement Learning
3	116U06O703	Web Analytics and Web Intelligence
4	116U06O704	Massive Graph Analysis

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Semester VIII - Credit Scheme (With Project)

Course Code	Course Name	Teaching Scheme (Hrs.)	Total (Hrs.)	Credits Assigned	Total credits	Course Category
		TH-P-TUT		TH- P- TUT		
116U01P801	Project -II	0-16-0	16	0-8-0	8	PR
116U01E85x	Departmental Elective-V	2-0-0	2	2-0-0	2	PE
116U01E86x	Departmental Elective-VI	2-0-0	2	2-0-0	2	PE
116U01L85x	Departmental Elective-V Laboratory	0-2-0	2	0-1-0	1	PE
116U01L86x	Departmental Elective-VI Laboratory	0-2-0	2	0-1-0	1	PE
	Total	4-20-0	24	4-10-0	14	

SVU_TY_2020
Semester VIII - Examination Scheme (With Project)

Course Code	Course Name	Examination Scheme							
		Theory Marks				TW	Oral	Pract. and Oral	Total
		Continuous Assessment (CA)			End Sem. Exam				
		ISE	IA	Total					
116U01P801	Project II	--	--	--	--	50	50	--	100
116U01E85x	Departmental Elective-V	30	20	50	50	--	--	--	100
116U01E86x	Departmental Elective-VI	30	20	50	50	--	--	--	100
116U01L85x	Departmental Elective-V Laboratory	-	-	-	-	25	25	--	50
116U01L86x	Departmental Elective-VI Laboratory	-	-	-	-	25	25	--	50
	Total	**60**	**40**	**100**	**100**	**100**	**100**	**--**	**400**

Departmental Elective – V for VIII Semester

Sr. No.	Course Code	Name of Electives	Remarks
1	116U01E851	Bioinformatics	
2	116U01E852	Advanced Algorithms: Design and Analysis	
3	116U01E853	Internet of Everything	
4	116U01E854	Deep Learning	Not available to students with Honours in Data Science and Analytics
5	116U01E855	Business Analytics	Not available to students with Honours in Data Science and Analytics

Departmental Elective – VI for VIII Semester

Sr. No.	Course Code	Name of Electives	Remarks
1	116U01E861	Game Programming	
2	116U01E862	IoT Security	
3	116U01E863	Cyber Physical Systems	
4	116U01E864	Natural Language Processing	
5	116U01E865	High Performance Computing	
6	116U01E866	Blockchain Architecture and Application Development	Not available to students with Honours in cyber Security and forensics

Credit Scheme (With Semester Long Internship for Selected Students)

Course Code	Course Name	Teaching Scheme (Hrs.)	Total (Hrs.)	Credits Assigned	Total credits	Course Category
		TH-P-TUT		TH- P- TUT		
116U01P801	Semester long Internship$	-	-	0-11-0	11	PR
116U01E85x	Departmental Elective: Online NPTEL / Coursera course*	-	-	3-0-0	3	PE
	Total	-	-	3-11-0	14	

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Examination Scheme (With Semester Long Internship)

Course Code	Course Name	Examination Scheme							
		Theory Marks				TW	Oral	Pract. and Oral	Total
		Continuous Assessment (CA)			End Sem. Exam				
		ISE	IA	Total					
116U01P801	Semester long Internship $	--	--	--	--	-	-	-	200
116U01E85x	Departmental Elective: Online NPTEL / Coursera course *	-	-	-	-	-	-	-	-
	Total								**200**

$- Will be evaluated by Internal and external examiners at two stages along with feedback from Industry.
*** Marks/ grade will not be considered for SGPI calculations. Credits will be awarded on successful completion of online course.**

For details of Semester long internships, refer to Internship cell policy and Documents.
Note:
As per college internship policy, it is mandatory for every student to complete 10 weeks of Internship spanning over the four years of B.Tech Programme which is over and above the academic credits.
Students can take up internships in community services / socially relevant projects (optional and limited to 4 weeks) and in the technical domain (minimum 6 weeks or more). Students will be awarded an internship completion certificate along with their graduation.

SEMESTER - VII

Course Code	Course Title							
116U01C701	**Software Architecture and Design Thinking**							
	TH		**P**			**TUT**		**Total**
Teaching Scheme(Hrs.)	**03**		**--**			**--**		**03**
Credits Assigned	**03**		**--**			**--**		**03**
Examination Scheme	**Marks**							
	CA		**ESE**	**TW**	**O**	**P**	**P&O**	**Total**
	ISE	**IA**						
	30	**20**	**50**	**25**	**25**	**--**	**--**	**100**

Course prerequisites (if any): Students should be familiar with basic concepts of Software Engineering

Course Objectives

1. Develop architectural thinking applicable in building large and complex systems.
2. Structural and behavioral models in design notations such as Architecture description languages (ADLs).
3. Analyzing role of architectures in various environments.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Design the architecture of software systems in various architectural styles
CO2	Analyze software architecture using analysis techniques
CO3	Apply the concepts of Design thinking for development of product/ service
CO4	Refinement, Prototyping, Implementation of product/ service

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Software Architecture**		**12**	CO1
	1.1	Basic Concepts, Elements of an Architecture Design, Designing Architectures Conventional Architectural styles : Concepts of Software Architecture, Models, Processes, Stakeholders Creating An Architecture Design		
	1.2	Styles and Architectural Patterns, Pipes and Filters, Event- based		
	1.3	Implicit Invocation, Layered systems, Repositories, Interpreters		
	1.4	Architectural Design process		
	#SELF LEARNING: Logic Building for development of a Software System			
2	**Connectors :**		**06**	CO1
	2.1	Connector Foundations, Connector Roles		
	2.2	Connector Types and Their Variation Dimensions		
3	**Modeling , Analysis :**		**10**	CO2
	3.1	Modeling Concepts, Ambiguity, Accuracy, and Precision,		
	3.2	Complex Modeling: Mixed Content and Multiple Views. Analysis Goals, Scope of Analysis, Architectural Concern being		
	3.3	Analyzed, Level of Formality of Architectural Models, Type of Analysis, Analysis Techniques		
	3.4	Designing for Non-Functional Properties and implementation		
	#SELF LEARNING: SAAM			
4	**Introduction to design thinking**		10	CO3
	4.1	The Power of Design Thinking Stages of thinking: The design process: Define, Research, Ideate, Prototype, Select, Implement, Learn, Example project		
	4.2	Research: Identifying drivers, Information gathering, Target groups, Samples and feedback		
	4.3	Idea generation: Basic design directions, Themes of thinking, Inspiration and references, Brainstorming, Value, Inclusion, Sketching, Presenting ideas		
5	Refinement, Prototyping, Implementation		**07**	CO4
	5.1	Refinement : Thinking in images and signs, Appropriation, Modification, Thinking in shapes and colours		
	5.2	Prototyping : Developing designs, ‘Types’ of prototype, Vocabulary		

	5.3	Implementation: Format, Materials, Finishing, Media, Scale, Series/Continuity		
	#Self-Learning: Introduction to Design Parallax			
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Richard N. Taylor, Nenad Medvidovic, Eric Dashofy	, "Software Architecture: Foundations, Theory, and Practice"	Publisher: Wiley. ISBN: 978-0-470-16774-8	10th Edition, 2010
2.	Alan Dennis, Barbara Haley Wixom, Roberta M. Roth	System Analysis And Design	John Wiley & Sons, Inc.	7th Edition
3.	M. Shaw	"Software Architecture Perspectives on an Emerging Discipline"	Prentice-Hall of India Pvt.Ltd	1996, 1st Edition
4.	Len Bass, Paul Clements, Rick Kazman	Software Architecture in Practice	O Reilly	3rd Edition
5.	Gavin Ambrose Paul Harris	Design thinking	Published by AVA Publishing SA	1St Edition
6.	Tim Brown with Barry Katz	Change by Design	Harper Collins e-books	1st Edition

Course Code	Course Title						
116U01L701	Software Architecture and Design Thinking Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Software Architecture and Design Thinking". Students will be graded based on continuous assessment of their term work.

DEPARTMENTAL ELECTIVES - III and IV

Course Code	Course Title							
116U01E731	Big Data Analytics							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			02		--		05
Credits Assigned	03			01		--		03
Examination Scheme	Marks							
	CA			ESE	TW	O	P	P&O	Total
	T-1	T-2	IA						
	15	15	20	50	25	25	--	--	100

Course prerequisites (if any):
Database management system, Data mining

Course Objectives
1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSQL MapReduce.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1 Interpret the fundamental enabling techniques like Hadoop, MapReduce in achieving Big data analytics
CO2 Illustrate techniques used for finding similarity and dimensionality reduction in large dataset
CO3 Interpret business models, scientific computing paradigm and apply scalable algorithms for Big data analytics.

CO4 Demonstrate the perspective of big data analytics in various applications like recommender systems, social media applications etc.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Big Data and mining large scale system**		11	CO1
	1.1	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.		
	1.2	Introduction to Hadoop and its components		
	1.3	Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.		
	1.4	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.		
2	**Finding Similar Items and Dimensionality Reduction**		08	CO2
	2.1	Applications of Near-Neighbor Search- Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem.		
	2.2	Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.		
	2.3	Shingling of Documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Applications of Locality-Sensitive Hashing		
	2.4	Dimensionality Reduction: Eigenvalues and Eigenvectors of Symmetric Matrices, Principal-Component Analysis, Singular-Value Decomposition CUR Decomposition		
		#Self-learning : Latent factor models, Methods of High degree of similarity		
3	**Mining Data Streams**		06	CO3
	3.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Query, Issues in Stream Processing.		
	3.2	Sampling Data in a Stream: Obtaining a Representative Sample, The General Sampling Problem, Varying the Sample Size.		
	3.3	Filtering Streams: The Bloom Filter, Analysis		
	3.4	Counting Distinct Elements in a Stream: The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements. Estimating Moments		

		Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm.		
		Self-learning: Query Answering in the DGIM Algorithm, Decaying Windows.		
4	**Link Analysis And Frequent Item sets**		**08**	**CO3**
	4.1	PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. Topic sensitive Page Rank, Hubs and Authorities		
	4.2	Handling Larger Datasets in Main Memory Algorithm of Park, Chen, and Yu, All or Most frequent itemsets in two passes.		
		The SON Algorithm and MapReduce, Toivonen's Algorithm		
		Self-learning: link spam, The Multistage Algorithm, The Multihash Algorithm. Counting Frequent Items in a Stream Sampling Methods for Streams, Frequent Item sets in Decaying Windows		
5	**Clustering and Mining Social Network and graphs**		**12**	**CO4**
	5.1	CURE Algorithm, Clustering in Non-Euclidean Spaces		
	5.2	Recommendation Systems – A model for Recommendation systems, Content based recommendation, Collaborative Filtering		
	5.3	Mining Social-Network Graphs – Social networks as graphs, Clustering, Direct discovery of communities, Partitioning of Graphs, Finding overlapping of communities, SimRank, Counting Triangles		
		#Self-learning: Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries **Neighborhood properties of graph, Adverting on Web**		
Total			**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Anand Rajaraman and Jeff Ullman	Mining of Massive Datasets	Cambridge University Press	Second Edition , 2014
2.	Alex Holmes	Hadoop in Practice	Manning Press, Dreamtech Press.	Second Edition , 2015
3.	Bill Franks	Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics	Wiley	2012
4.	Chuck Lam	Hadoop in Action	Dreamtech Press	2011
5.	Radha Shankarmani M. Vijaylakshmi	Big Data Analytics	Wiley	2st edition, 2018

Course Code	Course Title						
116U01L731	Big Data Analytics Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Big Data Analytics". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
116U01E732	Cyber Security, Forensics & Cyber Law						
	TH		P	TUT			Total
Teaching Scheme(Hrs.)	03		--	--			03
Credits Assigned	03		--	--			03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any): **Computer Organization & Architecture, System Security, Computer Networks.**

Course Objectives: The objective of the course is to enable students to understand the basic principles of information security, computer crimes and methods of defense. The course introduces the process of digital forensic investigation, extraction of evidence using appropriate tools. It covers the techniques of data hiding, recovery, disk analysis, volatile data extraction. Further, it explores different network based attacks, tools to monitor/mitigate such attacks. Tools such as metasploit, interfaces to dark web and deep web explore the conducive environment for attackers. Cyber laws, IT Acts enable the student to understand the legal aspects of various cyber-crimes.

Course Outcomes:
At the end of successful completion of the course the student will be able to:

CO1	Identify various security goals, computer crimes & methods of defence.
CO2	Understand the fundamentals of digital forensics.
CO3	Analyze and interpret the results of disk forensic operations.
CO4	Apply forensic tools to extract and investigate the evidences from network.
CO5	Relate the corresponding computer security acts with the crimes.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Security Architecture**		03	CO1
	1.1	Introduction to information security, security goals, security services, attacks & its types, security mechanism.		
	1.2	Introduction to cyber security, cyber-crimes, its origins, classification of cyber-crimes, cyberspace and cyber profiling.		
2	**Data Privacy and Theft**		10	CO2
	2.1	Data theft - Adwares, malwares, ransomwares, trojans, spywares, keyloggers, phishing & its types, SQL injection attacks.		
		#Self-Learning - Data privacy law in India.		
	2.2	Identity theft, its types, prevention techniques, software piracy.		
		#Self-Learning – Case study on identity theft.		
	2.3	Data privacy, issues surrounding data privacy, guidelines for data privacy, data privacy vs data security, data privacy mechanisms, legislations on data privacy - local and global.		
		#Self-Learning - GDPR Compliance		
3	**Digital Forensics Fundamentals**		10	CO3
	3.1	Introduction, six A's of digital forensics, digital evidence, digital investigations, incident response, incident response methodology.		
	3.2	Classification of digital evidence - volatile and non-volatile, rules and guidelines for extraction of digital evidence, forensic duplicates, establishing chain of custody, admissibility of evidence in the court of law.		
		#Self-Learning – CERT and its role in digital investigation.		
	3.3	Information retrieval and recovery, cloning techniques, password cracking, data recovery from file systems and mobile devices, forensics audit, tools for forensic investigation, anti-forensics.		
4	**Network Forensics**		12	CO4
	4.1	Network based attacks – MITM, OWASP, ARP spoofing, IP and MAC spoofing, DNS attacks, SYN flooding attacks, port scanning, DOS, DDOS.		
	4.2	Sources of Digital Evidence from Emails, Web usage, Network Traffic, Email forensic and investigations.		
		Network Forensic Tools & Applications – Browser forensics, Nmap, Nessus, Wireshark, Metasploit, Kali-Linux, Deep-Web, Dark-Web.		

		#Self-Learning : Criminal cases strongly based on digital evidences		
5	**Cyber Law**		**10**	**CO5**
	5.1	Fundamentals of Cyber Law-Legislative, Judicial, Quasi-judicial, Investigative and International Cyber Law Framework.		
		#Self-learning : Cyber-crime cases studies- sample list but not limited to: Shreya Singhal v Union Of India, Syed Asifuddin v The State of Andhra Pradesh, Chambers v. Director of Public Prosecutions (UK), Riley v California (US), US v Ross William Ulbricht Carpenter v US, Packingham v North Carolina, Reno v ACLU, In Re: Nickelodeon Consumer Privacy Litigation, In Re: Google Inc. Cookie Placement Consumer Privacy Litigation, Memorandum of Decision - Google warrant case		
	5.2	Intellectual Property Issues & Cyberspace - Computer Software & Copyright Law, Software Licenses, Computer Databases & the Law, Domain Names & the Law, Trademark issues in Cyberspace and Semiconductor Layout & Design Law.		
	5.3	Cyber Crime Law in India- Cyber Frauds, Computer Source Code, Cyber Pornography, Cyber Terrorism, Data Privacy & confidentiality, Digital Signature, Freedom of speech, Information & Traffic Data, Intermediaries, Malware, Unauthorized Access and Violation of privacy.		
		#Self-Learning- A Global Protocol on Cybersecurity and Cybercrime		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Bill Nelson, Amelia Phillips, Christopher Steuart.	Guide to Computer Forensics and Investigations.	Cengage Learning, USA.	3rd Edition paperback, 2002.
2.	Jason T. Luttgens, Mathew Pepe, Kevin Mandia	Incident Response and Computer Forensics.	Tata McGraw Hill Education	3rd Edition, 2014.
3.	Marie-Helen Maras	Computer Forensics: Cybercriminals, Laws and Evidences	Jones and Bartlett Learning	2nd Edition, 2014
4.	Davidoff Ham	Network Forensics Tracking Hackers through Cyberspace	Pearson India	1st Edition, 2013.
5.	Adv. Prashant Mali	Cyber Law and Cyber Crimes Simplified	Cyber Infomedia	January 2017.
6.	Asian School of Cyber	https://www.asianlaws.org/		

Course Code	Course Title						
116U01L732	Cyber Security, Forensics & Cyber Law Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Cyber Security, Forensics & Cyber Law". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E733	Geographic Information System and Spatial Computing							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			02		--		05
Credits Assigned	03			01		--		04
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites: Database

Course Objectives:

The objective of this course

1. Identify principles and functional issues pertaining to physical geography applications of GIS
2. To collect, analyse and manipulate spatial data.
3. Provide efficient means to produce maps and other products in the standard formats for different uses.
4. To support research activities using spatial as well as non-spatial data.
5. Complex analysis/queries involving geographical reference data to generate new information

Course Outcomes

On completion of the course students will be expected to

1. Understand of core concept that define the Geographical Information System
2. Perform spatial analysis on Vector and Raster data models
3. Use terrain and spatial interpolation methods for surface analysis.
4. Examine linear features and movement on spatial data using network analysis
5. Use spatial regression models for modelling GIS data.

Module No.	Unit No.	Details	Hrs.	CO
1	Fundamentals of GIS		**6**	**CO**
	1.1	Introduction, Definition of GIS, Evolution of GIS , components of GIS		
	1.2	Geospatial Data, Geographic Coordinate System, Map Projections, Commonly Used Map Projections, UTM grid system, Map Scale		
	1.3	Cartographic Symbolization, Types of Maps, Typography, Map Design, Map Production		
2	Data Management, Models and Quality Issues		**9**	**CO**
	2.1	Vector Data Model : Topology, Non topological Vector models, Attribute Data in GIS, Attribute Data Entry, Vector Data Query, Manipulation of Fields and Attribute Data		
	2.2	Raster Data Model : Elements of Raster Data Model, Types of Raster Data, Raster Data Structure, Raster Data Query, Data Compression, Data Conversion, Integration of Raster and Vector data		
	2.3	Data input and editing, Data quality Issues: Accuracy, Consistency, Precision and Resolution, Completeness; source s of error in GIS		
3	GIS Data Exploration and Analysis		**10**	**CO**
	3.1	Data exploration: Descriptive statistics, Graphs, Dynamic Graphics		
	3.2	Vector Data Analysis: Buffering, Overlay, Distance Measurement, Pattern Analysis, Map Manipulation		
	3.3	Raster Data Analysis: Local Operations, Neighborhood Operations, Zonal Operations, Data Extraction, Data Generalization, Comparison of Vector and Raster Based Data		
4	**Surface Mapping and Analysis**		**9**	**CO**
	4.1	Terrain Analysis: Data for Terrain Mapping and analysis, Terrain Mapping, slope and aspect, Surface curvature, Raster vs TIN , View shed and water shed analysis .		
	4.2	Spatial Interpolation: Elements of Spatial Interpolation, Global methods, Local Methods, Kriging, Comparison of Spatial Interpolation Methods		
5	**Spatial Modeling & applications**		**6**	**CO**
	5.1	GIS Model and Modeling: Basic Elements of GIS Modeling		
	5.2	Types of Model: Binary Model, Index Model, Regression Model, Process Model and their Applications		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Kang-tsung Chang	"Introduction to Geographical Information Systems",	Tata McGraw Hill	Third Edition, 2003
2.	P. A. Burrough and R. A. McDonnell	Principles of Geographic Information Systems	Oxford University Press	1999
3.	Basudeb Bhatta	"Remote Sensing and GIS"	,Oxford University Press	2nd Edition
4.	Ian Heywood, Sarah Cornelius &etal	"An Introduction to Geographical Information Systems"	Pearson Education	2nd Edition
5.	S Chandra	"Remote Sensing"	Narosa Publications	

Course Code	Course Title						
116U01L733	Geographical Information Systems and Spatial Computing Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Geographical Information Systems and Spatial Computing". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E734	User Experience Design							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	03			--		--		03
Examination Scheme	Marks							
	CA			ESE	TW	O	P	P&O	Total
	T-1	T-2	IA						
	15	15	20	50	25	--	--	25	150

Course prerequisites: Fundamentals of Software Engineering.

Course Objectives: The focus of this course is to introduce the learner to User Experience (UX) Design. User Experience design is design that is user centered. The goal is to design artifacts that allow the users to meet their needs in the most effective efficient and satisfying manner. Every digital interface/interaction (e.g. web and mobile application, car dashboard, smart appliance) is designed to solve a problem or to make our lives better, easier, more successful. User Interface (UI) design refers to the way the interface looks (the actual layout of its elements). User Experience (UX) design tackles how it feels to use the product (what do we do? how do we feel?). This course teaches the principles and practice of UI/UX design.

Course Outcomes

At the end of successful completion of the course the student will be able to

- CO1 Understand the fundamentals of human-computer interaction and its impact on UX design.
- CO2 Outline the importance of user centric design.
- CO3 Illustrate the working of UX design process.
- CO4 Analyze tools and techniques for prototyping and designing applications.
- CO5 Summarize the applications of UX design.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to User Interface Design**		06	CO1
	1.1	What is user experience design? What makes up user experience? Evolution of UX Design, Elements of user experience, requirements, strategy, design principles, user centric design.		
2	**User Research and Journey**		12	CO2
	2.1	Types of users, problem formulation for users (stakeholders), need finding, planning and execution for a user centered design.		
	2.2	5S model, User research, user research goals, heuristic analysis, user personas, identifying and recruiting users for the research.		
	2.3	User research methodologies - Qualitative and Quantitative analysis, user interviews, focused group discussion, expert reviews, tools for user research.		
3	**UX Design Process**		10	CO3
	3.1	Defining the UX Design Process and its Methodology, Understanding user needs, Flow chart, Six stages of UX Design process.		
	3.2	The four quadrants of empathy map, emotional mapping using an empathy map, Design Thinking, Wicked problems, Ideation.		
4	**Wire framing and Prototyping.**		12	CO4
	4.1	Visual design principles, Interaction design, Information design and data visualization, Information architecture.		
	4.2	Wire framing and storyboards, Digital Designs, Elements and Widgets, Screen design and layout, prototyping tools.		
	4.3	Usability testing – types and process.		
5	**Applications and Future of UXD**		5	CO5
	5.1	Introduction to Augmented Reality (AR) and Virtual Reality (VR), UXD and XR, present and future of XR.		
		#Self-learning: Case studies on UXD.		
		Total	45	

 # Students should prepare all Self-Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1	Don Bradman	*The Design of Everyday Things*	Basic Books	Reprint Edition 2002.
2	Allan Cooper, Robert Reimann, David Cronin, Christopher Noessel.	*About Face: The Essentials of Interface Design, 4ed (WILEY)*	Wiley Publications.	4th Edition, 2016.
3	Steve Krug	*Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability*	Pearson Education	Third Edition, 2015.
4	Daniel Kahneman	*Thinking, Fast And Slow*	Penguin Press	2012 Edition
5	Russ Unger, Carolyn Chandler	*A Project Guide to UX Design: For user experience designers in the field or in the making (Voices That Matter)*	New Riders	2nd Edition, 2012.

Term-Work will consist of Practical experiments covering the entire syllabus. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
116U01L734	User Experience Design Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "User Experience Design". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E735	Reinforcement Learning							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			02		--		05
Credits Assigned	03			01		--		04
Examination Scheme	Marks							
	CA			ESE	TW	O	P	P&O	Total
	T-1	T-2	IA						
	15	15	20	50	25	25	--	--	150

Course prerequisites:
Linear algebra
Probability and statistics
Multivariate calculus
Algorithms
Programming language such as Python

Course Objectives
1. Comprehension of fundamentals of reinforcement learning
2. Application of various RL methods for
3. Analysis using temporal difference and deep learning methods
4. Evaluation of various methods of RL for application development

Course Outcomes
At the end of successful completion of the course the student will be able to
CO1. Interpret fundamentals of Reinforcement learning methods
CO2. Apply various dynamic programming and Monte-Carlo methods
CO3. Apply different temporal difference learning policies
CO4. Use n-step bootstrapping policies
CO5. Apply planning and learning for different methods

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Reinforcement Learning**		**08**	**CO 1**
	1.1	Elements of Reinforcement Learning, Limitations and scope		
	1.2	Markov Decision Processes to solve real-world problems, Goals and rewards, Policies and value functions		
	1.3	Bellman equations for Markov Decision Processes		
2	**Dynamic Programming and Monte Carlo Methods**		**10**	**CO2**
	2.1	Iterative policy evaluation, Policy improvement, Policy iteration and value iteration		
	2.2	Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming		
	2.3	Classic Monte Carlo prediction and control methods, Greedy and epsilon-greedy policies, Exploration-Exploitation Dilemma and its solutions		
3	**Temporal Difference Learning**		**10**	**CO3**
	3.1	TD Prediction ,Advantages of TD Prediction Methods		
	3.2	Sarsa: On-policy TD Control		
	3.3	Q-learning: Off-policy TD Control		
4	**n-step Bootstrapping**		**08**	**CO4**
	4.1	n-step TD Prediction, n-step Sarsa, n-step Off policy		
	4.2	Off policy Learning Without Importance Sampling: The n-step Tree Backup Algorithm		
5	**Planning and Learning**		**09**	**CO 5**
	5.1	Models and Planning, Dyna: Integrated Planning, Acting, and Learning		
	5.2	When the Model Is Wrong , Prioritized Sweeping , Expected vs. Sample Updates		
	5.3	Trajectory Sampling, Real-time Dynamic Programming, Planning at Decision Time		
	Self-Learning Topic: Deep learning model design using Python library functions from PyTorch, Tensorflow and Keras			
		Total	**45**	

Laboratory experiments are stated for added credit is given in the Laboratory scheme

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Richard S. Sutton and Andrew G. Barto	*Reinforcement Learning: An Introduction*	The MIT Press	Second Edition, 2018
2.	Stuart Russell and Peter Norvig	*Artificial Intelligence: A Modern Approach*	Pearson	3 rd edition, 2010
3.	Robert Tibshirani, and Jerome Friedman	*The Elements of Statistical Learning, Trevor Hastie*	Springer	2nd edition, 2009
4.	M. Gopal	*Applied Machine Learning*	Mc-Graw Hill Education India Pvt. Ltd.	Print edition: ISBN-13: 978-93-5316-025-8,
5.	Chris Bishop	*Pattern recognition and machine learning (PRML)*	Springer	ISBN-13: 978-0387-31073-2, 2006

Term-Work will consist of Practical experiments covering the entire syllabus. Students will be graded based on continuous assessment of their term work

Course Code	Course Title						
116U01L735	Reinforcement Learning Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Reinforcement Learning". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E736	**Secure Coding**							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	03			--		--		03
Examination Scheme	Marks							
	CA			ESE	TW	O	P	P&O	Total
	T-1	T-2	IA						
	15	15	20	--	--	--	--	--	50

Course Prerequisites (if any):
Knowledge of programming languages, cryptography, web development

Course Objectives:
Understanding Application Security, Threats, and attacks. Learning the security coding Practices and architecture.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1 Understand secure coding best practices, procedures, policies and software vulnerabilities
CO2 Apply secure coding practices to address malicious and non-malicious program errors.
CO3 Use appropriate techniques and tools to analyze and test software applications for weaknesses and vulnerabilities
CO4 Design and implement software applications using secure architecture concepts

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction**		**08**	
	1.1	The Philosophy of Secure Programming, Defining Secure Programming, Robust vs. Secure Programming, Security Policies and Procedures, Secure Programming General Philosophy, Where to Look for Vulnerabilities, Secure Programming best practices,		CO1
	1.2	Vulnerabilities in various programming languages, Vulnerabilities in various domains: Web Application, Mobile Applications and Database Applications Dangers of Vulnerable Components/Programs		
	1.3	Understanding secure SDLC model, Methodologies for developing secure code: Risk analysis, threat modelling, and guidelines for secure coding practice.		
2	**Secure programming techniques**		**14**	
	2..1	*Malicious Program Errors; Worms, Viruses, Trojan, Trapdoor, Salami Attack and Other Malware, , ClientState Manipulation		CO2
	2.2	*Non-Malicious Program Errors; Buffer Overflows, Numeric Overflow, Incomplete Mediations, Race Conditions/Time-of-Check to Time-of-Use Errors, SQL Injection, Password generation and storage Security		
	2.3	Controls against Malicious and Non- Malicious Program Errors: Developmental Control, OS Controls on user program, Administrative Control and Program Controls in general.		
	2.4	Secure Programming Tools (Secure Code Warrior or any other/s)		
		#Self-Learning secure coding practices for C, C++, Java, python, and PHP		
3	**Cross-Domain Security in Web Applications**		**08**	
	3.1	Interaction Between Web Pages from Different Domains, Introduction to session management in web applications, secure coding practices for error handling, session hijacking, session fixation: attacks, vulnerabilities and controls		CO3
	3.2	Attack patterns, preventing XSRF attack, preventing XSSI, XSSI vs XSRF		
	3.3	Using OWASP tool for : injection, broken authentication, sensitive data exposure, cross-site scripting website security audit tools		
		Self-study: Using OWASP tool for: broken access control, security misconfiguration, insufficient logging and monitoring Secure Code Warrior		
5	**Secure architecture and Principles of secure designing**		**10**	
	5.1	What is security architecture?		CO4
	5.2	Principles of security architecture, principles of secure software development, case study: Java sandbox		
	5.3	Secure design steps, Secure deployment and maintenance,		

		Security Auditing		
		Total	**45**	

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*Suggestive list of Malicious and Non- Malicious Program Errors, Teachers might Add more errors based on latest research findings.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
	Mark G. Graaff, Kenneth R. van Wyk	Secure Coding: Principles and Practices	O'Reilly	2003, First Edition
1.	Pfleeger and Pfleeger	Security in computing	Pearson Education	Third Edition
2.	Michael Howard, David LeBlanc	Writing secure code	Microsoft Press	Second Edition
3.	Neil Daswani, Christoph Kern, and Anita Kesavan.	Foundations of Security	Apress	2007,First Edition

Course Code	Course Title						
116U01L736	Secure Coding Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Secure Coding". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E737	Advanced Cloud Computing							
	TH		P	TUT	Total			
Teaching Scheme(Hrs.)	03		--	--	03			
Credits Assigned	03		--	--	03			
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course Prerequisites (if any):

- Fundamental knowledge on Operating system.
- Basics of client/server programming and network protocols.
- Basics of cloud computing

Course Objectives:

1. To introduce basic computing models and functions of those models.
2. To understand the current practices in cloud computing.
3. To understand the distributed computing models and technologies.
4. To understand the other advanced and research topics in cloud computing.
5. To understand cloud challenges related to AI, ML, IoT and edge computing.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Describe basics of cloud computing and its fundamentals.
CO2: Explain cloud infrastructure management and server less computing.
CO3: Describe the cloud challenges related to AI and ML.
CO4: Explain cloud for IoT and edge computing.

Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Cloud Computing		7	
	1.1	Introduction to cloud computing, Computing platforms and technologies, Types of clouds.		CO1
2	Cloud Computing Fundamentals		8	
	2.1	Cloud service models, Data centers , cloud infrastructure, VM, and containers, Elasticity and auto scaling , Cloud applications and workloads		CO1
3	Cloud Infrastructures		8	
	3.1 3.2	Large-scale cluster management. i.e., resource sharing, scheduling, provisioning. Container orchestration and microservice management Serverless computing and cloud functions		CO2
4	Cloud Computing and ML/AI		10	
	4.1 4.2	Large-scale machine learning service on clouds, Resource management for production-scale machine learning. Applied machine learning research in clouds. i.e., workload and error prediction, Current and future (system specific) research challenges for AI and ML		CO3
5	Cloud IoT and Edge		12	
	5.1 5.2	Cloud IoT and edge computing fundamentals, Edge computing applications. Future research direction/opportunity in the cloud and edge computing.		CO4
Self-Learning Component: Other advanced cloud computing applications				
		Total	45	

Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi	Mastering Cloud Computing	McGraw Hill Education Private Limited	2013
2.	Judith Hurwitz, R.Bloor,M.Kanfman, F.Halper	OpenStack Cloud Computing Cookbook	PACKT Publishing BIRMINGHAM - MUMBAI	Third Edition
3.	J.Vette, Toby J. Vette, Robert Elsenpeter	Cloud Computing: A Practical Approach	Tata McGraw Hill	1st, 2009
4.	Rajkumar Buyya, James Broberg, Andrzej Goscinski	Cloud Computing, Principles and Paradigms	Wiley	1st ,2013

Course Code	Course Title						
116U01L737	Advanced Cloud Computing Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Advanced Cloud Computing". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E741	Data Science							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	03		--		--		03	
Credits Assigned	03		--		--		03	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Students are expected to have basic knowledge of algorithms and programming experience.

Course Objectives
To develop practical data analysis skills, which can be applied to practical problems.
To develop fundamental knowledge of mathematical concepts needed for data science applications.
To develop practical skills needed in data analytics.
To explain how math and information sciences can be used for developing better algorithms and software.
To develop applied experience with data science software, programming, applications and Processes.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Describe the Data Science Process and how the components interact
CO2	Use R Programming to carry out basic statistical modelling and analysis.
CO3	Apply basic tools to carry out EDA for the Data Science process. CO4
CO4	Build data models and assess the data-based models
CO5	Apply data wrangling and feature selection and generation methods.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Data Science**		**06**	**CO1**
	1.1	Introduction to Applied Data Science: What is Data Science? - Big Data and Data Science, Datafication - Current landscape of perspectives - Skill sets needed and various application areas. Challenges and skill Sets needed and various applications areas.		
	1.2	Data Science process, Impact of applying Data Science in business scenario.		
	1.3	Introduction to need of estimation and validation for added value due to data science		
2	**Introduction to Mathematical Foundation**		**10**	**CO2**
	2.1	Use R language for Data Science		
	2.2	Linear algebra for data science: Matrix view for linear algebra, Solving linear equations, Eigen values and Eigen vectors		
	2.3	Statistical inference: Population, samples, Statistical modeling, random variables and probability distribution, Sample statistics, Hypothesis testing		
3	**Exploratory Data Analysis**		**10**	**CO3**
	3.1	Introduction to Exploratory Data Analysis Basic tools (plots, graphs and summary statistics) of EDA		
	3.2	Data Visualization - Basic principles, ideas and tools for data visualization and its applications		
4	**Introduction to Basic Machine Learning Algorithms**		**12**	**CO4**
	4.1	Linear Regression, k-nearest neighbors		
	4.2	Naïve Bayes classifier, Logistic regression Hierarchical clustering, Decision tree and random forest		
5	**Data Wrangling ,Feature selection and feature generation**		**07**	**C05**
	5.1	Data Wrangling: Data Workflow framework, Dynamics of Data Wrangling, Data Transformation and Data Profiling APIs and other tools for scrapping the Web,		
	5.2	Feature Generation and Feature Selection methods		
		# Self Learning –Mini Project		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Han, J., Kamber, M., Pei, J.	Data mining concepts and techniques	Morgan Kaufmann	2011
2.	James, G., Witten, D., Hastie, T., Tibshirani, R.	An introduction to statistical learning with applications in R	Springer	2013
3.	Cathy O'Neil and Rachel Schutt	Doing Data Science, Straight Talk From The Frontline	O'Reilly	2014
4.	Kevin P. Murphy	Machine Learning: A Probabilistic Perspective	ISBN 0262018020	2013
5.	Ragunathan Rengaswamy, Resmi Suresh	Data Science for engineers	CRC press	2022
6.	Avrim Blum, John Hopcroft, and RavindranKannan	Foundations of Data Science	ONLINE	2014

Course Code	Course Title						
116U01L741	Data Science Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Data Science". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E742	Block Chain Technology							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	03		--		--		03	
Credits Assigned	03		--		--		03	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites:
Networking Concepts, Object Oriented Programming Skills, Cryptography and Network Security Concepts.

Course Objectives:

The objective of the Course is to explore the Bitcoin protocol followed by the Ethereum protocol – to lay the foundation necessary for developing applications and programming. Course will give the idea about the decentralized peer-to-peer network, an immutable distributed ledger and the trust model that defines a Blockchain.

This course explains basic components of a Blockchain (transaction, block, block header, and the chain) its operations (verification, validation, and consensus model) underlying algorithms, and essentials of trust (hard fork and soft fork).

Course Outcomes:

CO1 Describe the basic concepts of Blockchain and Distributed Ledger Technology

CO2 Apply cryptographic hash required for Blockchain.

CO3 Categorize and discuss the consensus in Blockchain.

CO4 Infer the components of Ethereum ecosystem.

CO5 Design a private Blockchain platforms

Module No.	Unit No.	Details	Hrs.	CO
		Block Chain Technology		
1	**Introduction to Blockchain**		**8**	**CO1**
	1.1	Challenges Faced by Modern Businesses, What is Blockchain? , Building Blocks of Blockchain, Types of Blockchain,		
	1.2	Introduction to Blockchain Pillars, Cryptography, Consensus, Distributed Ledger:		
	1.3	A Block in a Blockchain: Structure of a Block, Block Header, Block Identifiers: Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Blockchain.		
2	**Bitcoin Blockchain**		**12**	
	2.1	Introduction to Bitcoin, Bitcoin Wallets, Bitcoin Block, Bitcoin Transaction, Bitcoin Scripts, Bitcoin Attacks, Bitcoin Network, Bitcoin Mining.		**CO2**
	2.2	**Basic Crypto Primitives:** Cryptographic Hash Function, Properties of a hash function, Hash pointer and Markel tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency.		
3	**Consensus and Mining**		**10**	**CO3**
	3.1	Problem, Independent Verification of Transactions, Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block header, Mining the Block, Successfully Mining the Block, validating a New Block, Assembling and Selecting Chains of Blocks, to different consensus algorithms Proof of Work and Proof of Stake, PBFT.		
	3.2	**Working with Consensus in Bitcoin**: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.		
4	**Public / Ethereum Blockchain**		**8**	**CO4**
	4.1	Ethereum components: miner and mining node, Ethereum virtual machine, Ether, Gas, Transactions, accounts, Solidity and smart contract development.		
	4.2	Introduction to Swarm and whisper, Remix IDE, Truffle Framework, Ethereum Networks, Ethereum Wallets Ethereum Clients, Web3.js, NFT.		
5	**Private Blockchain**		**8**	**CO5**
	5.1	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults:		

		Byzantine Fault Tolerant (BFT) and Practical BFT.		
6	**Applications of Blockchain**		**4**	
	6.1	Blockchain in IOT, banking and Finance, Government, Healthcare system, AI, Blockchain in Education, Energy, Supply chain, Real-state.		**CO1, 2 , 5**
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Andreas M. Antonopoulos	Mastering the Bitcoin: Programming the Open Blockchain	O' Reilly	2nd Edition, 2017
2.	Melanie Swan	BlockChian	O'Reilly	2015
3.	Nitin Gaur, Luc Desrosiers, Petr Novotny, Venkatraman Ramakrishna	Hands-On Blockchain with Hyperledger: Building decentralized applications with Hyperledger Fabric and Composer	Packt	Kindle Edition, 2018
4.	*Stephen Fleming business ecosystems*	*Blockchain Technology: Introduction to Blockchain Technology and its impact on*	Stephen Fleming	2017
5.	*Zeeshan-ul- hassan Usmani*	*Introduction to lockchain with Case Studies*	Guhftgu Publication	2018

Course Code	Course Title						
116U01L742	Block Chain Technology Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Block Chain Technology". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E743	Computer Vision							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	03			--		--		03
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Linear algebra, differential calculus, matrices, determinants
Course on Digital signal and Image Processing

Course Objectives

- Comprehension of Computer Vision techniques
- Introduction to camera model system, introduction to image matching and 3D reconstruction
- Overview of Image and video processing techniques
- Scene understanding and recognition.
- Applications to Computer Vision methodologies for atomization of various tasks.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Relate various Computer Vision method for designing innovative applications.
CO2	Apply camera model for binocular imaging systems
CO3	Experiment on different interest point detectors and descriptors for feature extractions.
CO4	Analyze and implement object recognition techniques from images and video frames.
CO5	Design customized algorithms for real world application using Computer Vision techniques.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Computer Vision**		**06**	**CO1**
	1.1	Introduction to image enhancement techniques in spatial and frequency domain, Image features and different levels, Overview of Diverse Computer Vision Applications from various domains such as Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing		
2	**Image Formation Models**		**12**	**CO2**
	2.1	Digital Image Formation and low-level processing, Overview fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc., Fourier Transform, Convolution and Filtering, Optimized thresholding Otsu's method and other Image Enhancement and representation techniques, Binary Machine Vision, Connected component labelling,		
	2.2	Camera model and Camera calibration, Binocular imaging systems, Epipolar geometry for stereo vision, from shading, Stereo Image analysis, Image matching techniques.		
		#Self-learning: 3D transformations and projections.		
3	**Feature Extraction, Shape representation and Segmentation**		**12**	**CO3**
	3.1	Boundary extraction and boundary descriptors, Gray level moments, Edge detectors - Canny, LOG, DOG, Corner detectors - Harris and Hessian Affine, Advanced feature detectors: SIFT, SURF, HOG, GLOH, Scale-Space Analysis-Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.		
	3.2	Contour based representation, Region based representation, Deformable curves and surfaces , Snakes and active contours, Level set representations, Region Growing, Edge Based approaches to segmentation, Gray level Co-occurrence matrix and Texture features.		
4	**Motion Estimation and Object Recognition**		**10**	**CO4**
	4.1	Regularization theory , Optical computation, Stereo Vision , Motion estimation , Structure from motion		
	4.2	Introduction to Object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition.		
5	**Applications**		**5**	**CO5**
	5.1	Applications: Face detection, Face recognition, 3D generations 3D shape models for various applications Application: Surveillance foreground background separation – particle filters Chamfer matching, tracking, and occlusion detection, Combining views from multiple cameras: In-vehicle vision system: locating roadway, road markings, identifying road signs		

Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books

Recommended Books: Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with country**	**Edition and Year of Publication**
1.	Robert Haralick and Linda Shapiro	*Computer and Robot Vision", Vol. I, II,*	Addison-Wesley	2001
2.	Richard Szeliski	*Computer Vision: Algorithms and Applications*	electronic copy available at (http://szeliski.org/Book)	2010
3.	Forsyth and J. Ponce	*Computer Vision: A Modern Approach, D.*	Prentice-Hall	Second Edition, 2011.
4.	R. Jain, R. Kasturi, B. G.Schunck	*Machine Vision*	McGraw Hill	1995

Course Code	Course Title						
116U01L743	Computer Vision Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Computer Vision". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E744	**Computer Simulation and Modeling**							
	TH			**P**		**TUT**		**Total**
Teaching Scheme(Hrs.)	**03**			**--**		**--**		**03**
Credits Assigned	**03**			**--**		**--**		**03**
Examination Scheme	**Marks**							
	CA		**ESE**	**TW**	**O**	**P**	**P&O**	**Total**
	ISE	**IA**						
	30	**20**	**50**	**--**	**--**	**--**	**--**	**100**

Course prerequisites (if any):
Understanding of basic concepts of probability theory, algorithms and data structures.

Course Objectives:
This computer simulation and modeling course presents an introduction to discrete event simulation systems. The course discusses the modeling techniques of entities, queues, resources and entity transfers in discrete event environment. The course will teach the students the necessary skills to formulate and build valid models, implement the model, perform simulation analysis of the system and analyze results properly.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1 Understand the concepts of discrete event simulation and its importance in business, science, engineering, industry and other services.
CO2 Analyse and apply general principles of event scheduling algorithm & various statistical methods on different applications.
CO3 Generate pseudorandom numbers and perform statistical tests to measure the quality of a pseudorandom number generator.
CO4 Analyze the systems for input modeling and validation.
CO5 Estimate the different parameters of absolute and relative performance of different simulation systems.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Simulation, Simulation Examples & general principles**		12	CO1 & CO2
	1.1	Introduction to Simulation: advantages, disadvantages, types of models & steps in simulation study.		
	1.2	Simulation Examples: Manual Simulation: Queuing and Inventory problems		
	1.3	General Principles: Event Scheduling Algorithm/Time advance algorithm, Simulation using time advance algorithm.		
2	**Statistical & Queuing Models**		08	CO2
	2.1	Statistical Models in simulation: Discrete and Continuous Distributions.		
	2.2	Queuing Models: M/G/1, M/M/1		
		#Self-learning: Simulation tools		
3	**Random Number Generation**		10	CO3
	3.1	Random Number Generation Techniques		
	3.2	Testing random numbers: Chi square, K-S, Runs up and Down test.		
	3.3	Random Variate Generation: Inverse transform technique, Convolution Method & Acceptance-Rejection Technique		
4	**Analysis of simulation data**		08	CO4
	4.1	**Input Modeling** : Data collection, Identifying the Distribution with Data, Parameter Estimation, Goodness-of-Fit Tests,		
	4.2	Selecting Input Models without Data and Multivariate and Time-Series Input Models		
	4.3	**Verification and Validation of Simulation Models:** Verification, Calibration and Validation of Simulation models.		
5	**Estimation of Absolute & Relative Performance:**		07	CO5
	5.1	**Output Analysis:** Estimation of absolute performance, Output Analysis Concepts, output analysis for steady state simulation.		
	5.2	Comparison of two and multiple system designs, metamodeling & optimization via simulation.		
		#Self-learning: Simulation application on manufacturing & material handling, networked computer systems.		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Jerry Banks, John Carson, Barry Nelson, and David M. Nicol	Discrete Event System Simulation	Prentice-Hall	Third Edition
2.	Jerry Banks, John Carson, Barry Nelson, and David M. Nicol	Discrete Event System Simulation	Prentice-Hall	Fifth Edition
3.	Averill M Law	System Modeling & Analysis;	Tata McGraw Hill	Fourth Edition
4.	Lawrence M. Leemis Stephen K. Park	Discrete-Event Simulation: A First Course	Pearson	First Edition
5.	Banks C M , Sokolowski J A	Principles of Modeling and Simulation	Wiley	2010

Course Code	Course Title						
116U01L744	Computer Simulation and Modeling Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Computer Simulation and Modeling". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E745	C# Programming and. Net Technology							
	TH		P			TUT		Total
Teaching Scheme(Hrs.)	03		--			--		03
Credits Assigned	03		--			--		03
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30*	20	50	--	--	--	--	100

*** The ISE and End Semester Exam is conducted in Lab for with Onscreen Mode with guidelines and instructions provided during/before the examination.**

Course prerequisites (if any):
Fundamentals of Object Oriented Programming concepts.

Course Objectives:

- Creating Form based application using WPF and .net Controls.
- Creating ASP.Net applications using standard .net controls.
- Connecting to data sources and managing them.
- Understand the fundamentals of developing modular application by using object oriented methodologies

.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Understand .NET framework & fundamentals.
CO2	Utilize the .NET framework to build distributed enterprise applications.
CO3	Implement ADO.NET and LINQ concept along with ASP.NET
CO4	Develop web applications using a combination of client-side (JavaScript, HTML, XML, WML) and server-side technologies (ASP.NET, ADO.NET).
CO5	Develop ASP.NET Web Services, secure web services, and .NET remoting applications

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to .NET technologies**		**05**	**CO**
	1.1	Features of .NET, .NET Framework, CLR, what is ASP.NET? Difference between ASP and ASP.NET. Design View, HTML View, Default Files used in ASP.NET		**1**
	1.2	Concept of Master pages, Intrinsic Objects of ASP.Net, Structure of ASP.NET page, Cascading Style Sheet: Embedded, Inline, External.		
2	**Controls in ASP.NET**		**12**	**CO**
	2.1	Overview of Dynamic Web page, Understanding ASP.NET Controls, Applications, Web servers, Installation of IIS. Web forms, web form controls -server controls, client controls		**2**
	2.2	Adding controls to a web form, Buttons, Text Box, Labels, Checkbox, Radio Buttons, List Box. Adding controls at runtime. Running a web Application, creating a multiform web project. Form Validation.		
	2.3	Client side validation, server Side validation, validation Controls: Required Field Comparison Range.		
		Self-Learning: Calendar control, Ad rotator Control, Internet Explorer Control.		
3	**Overview of ADO.NET and XML**		**13**	**CO**
	3.1	ADO.NET Fundamentals: Understanding Databases, Configuring Your Database, Understanding SQL Basics, Understanding the Data Provider Model, Using Direct Data Access, Using Disconnected Data Access.		3
	3.2	Data Binding: Introducing Data Binding, Using Single-Value Data Binding, Using Repeated-Value Data Binding, Working with Data Source Controls, The Data Controls: The GridView, Formatting the GridView, Selecting a GridView Row, Editing with the GridView, Sorting and Paging the GridView, Using GridView Templates, The DetailsView and FormView.		
	3.3	LINQ Architecture, LINQ to object, LINQ to SQL, LINQ to Dataset		
4	**ASP.NET Applications**		**07**	**CO**
	4.1	Creating, tracking, caching, error handling, Securing ASP.NET applications- form based applications, window based application. .NET Remoting.		4
5	**Web services**		**08**	CO
	5.1	Introduction, State management- View state, Session state, Application state, Building ASP.NET web services, working with ASP.NET applications, creating custom controls, Invoking COM/COM+, Active X Components		5
	5.2	Self-Learning: Deployment of ASP.NET application		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Peter Harrington	Machine Learning In Action	DreamTech Press	1st , 2012
2.	Ethem Alpaydın	Introduction to Machine Learning	MIT Pres	3rd,2014
3.	Tom M.Mitchell	Machine Learning	McGraw Hill	1st, 2017
4.	Stephen Marsland	Machine Learning An Algorithmic Perspective	CRC Press	1st, 2011

Course Code	Course Title						
116U01L745	C# Programming and. Net Technology Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "C# Programming And. Net Technology". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
116U01E746	Agile Project Management						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Software Engineering

Course Objectives
This course includes agile methodology, in different steps of project management like lifecycle, planning scheduling estimates etc.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Understand difference between traditional and agile methodology
CO2	Understand business case change in agile methodology
CO3	Apply planning and budget in agile development
CO4	Acquire skills for working in the team in agile development

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Agile Project management**		05	CO 1
	1.1	History, Background, and the Manifesto		
	1.2	Traditional Lifecycle		
	1.3	Agile Lifecycle		
	1.4	Scaling for Enterprise Agile		
	1.5	Four Agile Methodologies		
2	**The Agile Business Case, Quality in the Agile Space**		09	CO2
	2.1	The Business Case		
	2.2	Business Value Models		
	2.3	Project Balance Sheet		
	2.4	Building the Business Case by Levels		
	2.5	Quality Values and Principles		
	2.6	Thought Leaders and Agile Quality		
	2.7	Sampling for Quality Validation		
		#Self-Learning - Preparation of a business case		
3	**Agile in the Waterfall, Developing the Scope and Requirements**		10	CO3
	3.1	First Principles and Requisite Conditions		
	3.2	The Black Box, Interfaces, and Connectivity		
	3.3	Governing		
	3.4	Agile Scope		
	3.5	Envisioning		
	3.6	Requirements		
	3.7	Planning at a Distance		
		#Self-Learning : Application development by using Agile in waterfall model		
4	**Planning and Scheduling, Estimating Cost and Schedule.**		11	CO3
	4.1	Planning in the Enterprise Context		
	4.2	Scheduling		
	4.3	Other Plans in the Enterprise Agile Project		
	4.4	The Nature of Estimates		
	4.5	Drivers on Cost and Schedule		
	4.6	Building Estimates		
	4.7	The Social Unit		
	4.8	Principle and Values Guide Teams		
	4.9	Teams Are Building Blocks		
	4.10	Matrix Management in the Agile Space		
		#Self-Learning : Preparation of cost and schedule for the model.		
5	**Governance, Managing Value, Transitioning to Agile**		10	CO4
	5.1	Quality Principles		
	5.2	Governance Verifies Compliance		
	5.3	Defining and Accounting for Value		

	5.4	Burn-down Charts and Value Scorecards		
	5.5	Virtual Teams		
	5.6	Expand Throughput		
	5.7	Agile-by-contract Enables Scale		
	5.8	Business Leadership Transition		
	5.9	Customer Relationship Transition Project Management Transition Portfolio Management Transition Agile Transition in the Public Sector		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

1.	Project management the Agile way	John C Goodpasture, PMP	J. Ross publication	USA, Second edition
2.	Making Sense of Agile Project Management	Charles G. Cobb, PMP	2011 by John Wiley & Sons, I	First Edition
3.	Agile project management A practical guide to using Agile, Scrum and Kanban	Rob Cole and Edward Scotcher	2015, Rob Cole and Edward Scotcher	First Edition
4.	Agile for Project Managers	Denise Canty	2015, CRC Press	First Edition
5.	The Agile Enterprise: Building And Running Agile Organizations	Mario E. Moreira	2017, Apress	First Edition

Course Code	Course Title						
116U01L746	Agile Project management Lab.						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	--	--	25

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Agile Project management". Students will be graded based on continuous assessment of their term work.

Open Electives Technical

Course Code	Course Title							
116U06O701	Genetic Algorithm and Applications							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	02			--		--		02
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	--	--	--	--	--	50

Course prerequisites (if any):
Basics of Python Programming.

Course Objectives
The objective of this course is to introduce optimization techniques and application of genetic algorithms. The course also familiarizes students with the concepts of various operators and their implementation. Course mainly focuses on applying the genetic algorithm for a real life application.
.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Describe the concept of optimization
CO2	Understand the concept of genetic algorithms
CO3	Implement the component of GA to solve the problems.
CO4	Illustrate the application of GA in various domains.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction To Optimization**		03	CO1
	1.1	Finding the Best Solution - What Is Optimization? , Root Finding versus Optimization, Categories of Optimization		
	1.2	Minimum-Seeking Algorithms - Exhaustive Search, Analytical Optimization, Nelder-Mead Downhill Simplex Method, Optimization Based on Line Minimization		
	1.3	Natural Optimization Methods, Biological Optimization: Natural Selection		
2	**Introduction to Genetic Algorithms**		08	CO1, CO2
	2.1	What are genetic algorithms? Analogy of GA, Robustness of Traditional Optimization and Search methods – Goals of optimization-GA versus Traditional methods		
	2.2	Mathematical foundations: The fundamental theorem - Schema processing at work. – The 2-armed & k-armed Bandit problem. – The building Block Hypothesis. – Minimal deceptive problem		
3	**The Basic of Genetic Algorithm**		12	CO2
	3.1	Basic flow of a genetic algorithm, Selection Methods – Roulette wheel selection, stochastic universal sampling, rank-based selection, fitness scaling, tournament selection		
	3.2	Crossover Methods – Single, Two and k – point crossover, uniform crossover, crossover for ordered list		
	3.3	Mutation Methods – Flip bit mutation, swap mutation, inversion mutation, scramble mutation		
	3.4	Real-coded genetic algorithms – blend crossover and simulated binary crossover Understanding elitism		
4	**Solving Problems with Genetic Algorithms**		12	CO2,CO3
	3.1	Using the DEAP Framework – Introduction to DEAP, Using the creator module (fitness class), Using the Toolbox class (genetic operators) , OneMax Problem		
	3.2	Search Problems and Combinatorial Optimization – Knapsack and TSP		
	4.1	Constraint Satisfaction in search problems, Solving scheduling and N-queens problems		
	4.2	Optimizing Continuous Functions – chromosomes and genetic operators for real numbers, Using DEAP with continuous functions		
5	**Applications of Genetic Algorithms**		10	CO3,CO4
	5.1	Enhancing Machine Learning Models Using Feature Selection		
	5.2	**Hyperparameter Tuning of Machine Learning Models**		
		Total	45	

Recommended books

Sr. No	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1	Eyal Wirsansky	Hands-On Genetic Algorithms with Python	Packt Publishing ISBN: 9781838557744	Released January 2020
2	David E. Goldberg	*Genetic Algorithms in Search, Optimization and Machine Learning*	Pearson Education	2001
3	S.Rajesekaran, G. A.Viijayalakshmi Pai	*Neural Networks, Fuzzy Logic and Genetic Algorithms*	Pearson Education	2003
4	Banzhaf, Nordin, Keller and Francone, Morgan-Kaufmann	*Genetic Programming: An Introduction*	Morgan Kaufmann	February 1998
5	Riccardo Poli, Willian B. Langdon, Nicholas Freitag McPhee	*A Field Guide to Genetic Programming*	Lulu.com	March 2008
6	Clinton Sheppard	*Genetic Algorithms With Python*	Createspace Independent Pub	April 2016

Course Code	Course Title							
116U06O702	Reinforcement Learning							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	03			--		--		03
Examination Scheme	Marks							
	CA			ESE	TW	O	P	P&O	Total
	T-1	T-2	IA						
	15	15	20	50	--	--	--	--	100

Course prerequisites:
Linear algebra
Probability and statistics
Multivariate calculus
Algorithms
Programming language such as Python

Course Objectives
1. Comprehension of fundamentals of reinforcement learning
2. Application of various RL methods for
3. Analysis using temporal difference and deep learning methods
4. Evaluation of various methods of RL for application development

Course Outcomes
At the end of successful completion of the course the student will be able to
CO1. Interpret fundamentals of Reinforcement learning methods
CO2. Apply various dynamic programming and Monte-Carlo methods
CO3. Apply different temporal difference learning policies
CO4. Use n-step bootstrapping policies
CO5. Apply planning and learning for different methods

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Reinforcement Learning**		08	CO 1
	1.1	Elements of Reinforcement Learning, Limitations and scope		
	1.2	Markov Decision Processes to solve real-world problems, Goals and rewards, Policies and value functions		
	1.3	Bellman equations for Markov Decision Processes		
2	**Dynamic Programming and Monte Carlo Methods**		10	CO2
	2.1	Iterative policy evaluation, Policy improvement, Policy iteration and value iteration		
	2.2	Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming		
	2.3	Classic Monte Carlo prediction and control methods, Greedy and epsilon-greedy policies, Exploration-Exploitation Dilemma and its solutions		
3	**Temporal Difference Learning**		10	CO3
	3.1	TD Prediction ,Advantages of TD Prediction Methods		
	3.2	Sarsa: On-policy TD Control		
	3.3	Q-learning: Off-policy TD Control		
4	**n-step Bootstrapping**		08	CO4
	4.1	n-step TD Prediction, n-step Sarsa, n-step Off policy		
	4.2	Off policy Learning Without Importance Sampling: The n-step Tree Backup Algorithm		
5	**Planning and Learning**		09	CO 5
	5.1	Models and Planning, Dyna: Integrated Planning, Acting, and Learning		
	5.2	When the Model Is Wrong , Prioritized Sweeping , Expected vs. Sample Updates		
	5.3	Trajectory Sampling, Real-time Dynamic Programming, Planning at Decision Time		
	Self-Learning Topic: Deep learning model design using Python library functions from PyTorch, Tensorflow and Keras			
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Richard S. Sutton and Andrew G. Barto	*Reinforcement Learning: An Introduction*	The MIT Press	Second Edition, 2018
2.	Stuart Russell and Peter Norvig	*Artificial Intelligence: A Modern Approach*	Pearson	3 rd edition, 2010
3.	Robert Tibshirani, and Jerome Friedman	*The Elements of Statistical Learning, Trevor Hastie*	Springer	2nd edition, 2009
4.	M. Gopal	*Applied Machine Learning*	Mc-Graw Hill Education India Pvt. Ltd.	Print edition: ISBN-13: 978-93-5316-025-8,
5.	Chris Bishop	*Pattern recognition and machine learning (PRML)*	Springer	ISBN-13: 978-0387-31073-2, 2006

Term-Work will consist of Practical Experiments covering the entire syllabus. Students will be graded based on continuous assessment of their term work

Course Code	Course Title							
116U06O703	**Web Analytics and Web Intelligence**							
	TH		P	TUT				Total
Teaching Scheme(Hrs.)	03		--	--				03
Credits Assigned	02		--	--				02
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	--	--	--	--	--	50

Course Objectives:
Web Analytics is the measurement, collection, analysis, and reporting of Internet data for purposes of understanding and optimizing Web usage. Web Analytic is a tool that can measure Web site traffic. Businesses can also use it as a tool for business and market research.
Course includes definition and categories of Web Analytics, some examples of Web-based Analytics such as Google Analytics, and usage of EDDIE Tool.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1: Understand the concepts and terminologies related to web analytics.
CO2: Explore various parameters used for web analytics and their impact.
CO3: Explore the use of tools and techniques used in web analytics.
CO4: Develop experience on building websites, analysing web data insights and conversions.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Web Analytics**		**08**	**CO 1**
	1.1	Basics , Traditional Ways , Expectations		
	1.2	Data Collection , Clickstream Data , Weblogs , Beacons		
	1.3	JavaScript Tags , Packet Sniffing		
	1.4	Outcomes data , Competitive data , Search Engine Data		
2	**Qualitative Analysis**		**08**	**CO1**
	2.1	Customer Centricity, Site Visits		
	2.2	Surveys, Questionnaires, Website Surveys, Post visits, Creating and Running, Benefits of surveys		
	2.3	Critical components of successful strategy		
3	**Web Analytics**		**10**	**CO2**
	3.1	URLS, Cookies, Time on site , Page views , Understand standard reports		
	3.2	Website content quality, Navigation reports (top pages, top destinations, site overlay)		
	3.3	Search Analytics, Internal search, SEO and PPC, Measuring Email and Multichannel Marketing		
	3.4	Competitive intelligence and Web 2.0 Analytics – Segmentation – Connectable reports		
4	**Google Analytics**		**10**	**CO3**
	4.1	Analytics , Cookies , Accounts vs. Property		
	4.2	Tracking Code, Tracking Unique Visitors ,Demographics		
	4.3	Page Views & Bounce Rate Acquisitions ,Custom Reporting		
5	**Goals & Funnels**		**09**	**CO4**
	5.1	Filters , Ecommerce Tracking ,Real Time Reports, Customer Data Alert		
	5.2	Adwords Linking, AdSense Linking , Attribution Modeling		
	5.3	Segmentation ,Campaign Tracking , Multi-Channel Attribution		
#Self-learning : Web Intelligence 4.1 EDDIE Tool				
		Total	**45**	

Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Avinash Kaushik	Web Analytics 2.0: The Art of Online Accountability and Science Of Customer Centricity	Sybex	1st edition, 2009
2.	Michael Beasley	Practical Web Analytics for User Experience: How Analytics can help you Understand your Users	Morgan Kaufmann	2013
3.	Magy Seif El-Nasr, Anders Drachen, Alessandro Canossa, eds.	Game Analytics: Maximizing the Value of Player Data	Springer	2013
4.	Bing Liu	Web Data Mining: Exploring Hyperlinks, Content, and Usage Data	Springer	2nd Edition, 2011
5.	Justin Cutroni	Google Analytics	O'Reilly	2010
6.	Eric Fettman, Shiraz Asif, Feras Alhlou	Google Analytics Breakthrough	John Wiley & Sons	2016

Course Code	Course Title							
116U06O704	**Massive Graph Analysis**							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	03			--		--		03
Examination Scheme	Marks							
	CA			ESE	TW	O	P	P&O	Total
	T-1	T-2	IA						
	15	15	20	50	--	--	--	--	100

Course Prerequisites (if any):
Advanced database, data mining and Business Intelligence

Course Objectives:
1. To explore basic concepts of graph structured data and its Algorithms.
2. To learn different ways of modeling to store, retrieve and analyze the graph structured data.
3. To understand the applications of graph analytic techniques and advanced concepts in graph analytics

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Course Outcomes
At the end of successful completion of the course the student will be able to

CO1: To explore the concept of Graphs and to learn modeling and storing graph-structured data and related algorithms
CO2: To retrieve and analyze graph-structured data.
CO3: To understand the advanced concepts in graph analytic techniques
CO4: To understand applications of graph analytics.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction - Large Scale Graphs**		7	CO1
	1.1	Support for Graph Processing, Mapping Graph Algorithms to Architectures, applications of large Characteristics of large scale graph, Complex data sources, Social Networks, Simulations, Bioinformatics; Categories- Social, Endorsement, Location, Co-occurrence graphs; Graph Data structures, Parallel, Multicore, & Multithreaded Architectural scale graphs		
2	**Large-scale Graph Analysis**		12	CO2
	2..1	Parallel Prefix & List Ranking, Link Analysis, Page Ranking Algorithms		
	2.2	Parallel BFS, Spanning Tree, Connected Components, Minimum Spanning Tree Matroid Algorithm		
	2.3	Social Networking Algorithms, Parallel Betweeness Centrality.		
3	**Dynamic Parallel Algorithms**		10	CO2
	3.1	Streaming Data Analysis -Data Structures for Streaming Data - Tracking Clustering Coefficients -		
	3.2	Tracking Connected Components -Anomaly Detection, Massive-Graphs in Computational Biology, Genome Assembly.		
4	**Distributed Computation for Massive Data Sets**		8	CO3
	4.1	Spectral, Modularity-based Clustering, Random Walks; Large Graph Representation and Implementation- V-Graph Representation, Map Reduce, Surfer, Graph Lab.		
5	Advanced Massive Graph Analysis topics		08	CO4
	5.1	Power Law Distribution, Game-Theoretic Approach, Rank Aggregation and Voting Theory, Recommendation Systems, Social network analysis: case study -Facebook, LinkedIn, Google+, and Twitter.		
		Total	45	

Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Matthew O. Jackson	Social and Economic Networks	Princeton University Press	2010
2.	Stanley Wasserman, Katherine Faust	Social Network Analysis: Methods and Applications	Cambridge University Press	1995
3.	Tanja Falkowski,	Community Analysis in Dynamic Social Networks	University Magdeburg	2009
4.	Ladislav Novak, Alan Gibbons	Hybrid Graph Theory and Network Analysis	Cambridge Tracts in Theoretical Computer Science	2009
5.	Eric D. Kolaczyk	Statistical Analysis of Network Data Methods and Models	Springer Series in Statistics	2009

SEMESTER - VIII

Course Code	Course Title							
116U01E851	Bioinformatics							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	02			--		--		02
Credits Assigned	02			--		--		02
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Basic concepts of Programming

Course Objectives

The objective of this course will be to introduce students to the fundamentals of molecular biology and recent advances in genomics technology. The development of bioinformatics as an interdisciplinary field has introduced many sophisticated tools and techniques, to organize the information associated with biological molecules and contribute to our understanding of biological processes. On a larger scale, this has led to many practical applications, not only providing greater depth to biological research but also adding other dimensions to engineering applications. This course also aims to provide students with a practical and hands-on experience with common bioinformatics tools and databases.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1 Understand the scope of Bioinformatics
CO2 Understand popular bioinformatics database
CO3 Learn Fundamentals of Databases and Sequence alignment
CO4 Process, analyze, and manage biological information through Machine Learning Algorithms.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Bioinformatics**		**06**	**CO 1**
	1.1	Bioinformatics- History, Computational biology, Biological computing, Applications		
	1.2	Human Genome Project: History, Significance & applications. Introduction to important bioinformatics databases (NCBI, Uniprot, PDB and others)		
2	**Algorithms for biological sequence analysis**		**07**	**CO2**
	2.1	Introduction to python for bioinformatics, Visualization of Genomics, Sequencing technologies: Overview, Genome Assembly, Genome Annotation, Comparing Genomes		
	2.2	Pairwise sequence analysis, Multiple sequence analysis		
3	**Introduction to protein structure prediction**		**07**	**CO3**
	3.1	Predictive methods using protein sequences – protein identification, physical properties, motifs and patterns		
	3.2	3D structure prediction techniques, structure classification, Secondary structure prediction**,** Tertiary structure prediction		
4	**Machine Learning for Bioinformatic**s		**06**	**CO4**
	4.1	Intelligent systems, Hidden Markov model(HMM), Bayesian network(BN), Symbolic machine learning(Decision and identification trees), Application of Artificial intelligence(AI) for bioinformatics,		
	4.2	Application of Artificial intelligence (AI) for bioinformatics, Artificial neural network (ANN), and Stochastic context free grammar (SCFG), Genetic and Lamarckian algorithms.		
5	**Applications of Bioinformatics**		**04**	**CO4**
	5.1	Secondary Structure Prediction of Protein Secondary structure: basic principles on which the prediction methods of first, second and third generation are based		
	5.2	Algorithm of Chou-Fasman, GOR methods, other methods, predicting secondary structures using these methods and analysis		
		#Self-learning: Comparative and Functional Genomics, Concepts in measuring the accuracy of prediction (Q3, segment overlap, Mathew's correlation coefficient etc.)		
		Total	**30**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Pierre Baldi	Bioinformatics: The Machine Learning Approach (Adaptive Computation and Machine Learning series	Bradford	2008
2.	Dan E. Krane	Fundamental Concepts of Bioinformatics	Pearson	2009
3.	Andreas Baxevanis	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins	Wiley-Interscience	2001

Course Code	Course Title						
116U01L851	Bioinformatics						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "**Bioinformatics**". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E852	Advanced Algorithms: Design and Analysis							
	TH		P			TUT		Total
Teaching Scheme(Hrs.)	02		--			--		02
Credits Assigned	02		--			--		02
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any): Data structures, Analysis of algorithms

Course Objectives

This course is concerned with the study of algorithms for solving practical problems efficiently, and the theoretical analysis of their performance. There will also be an introduction to complexity theory, the formal study of algorithm performance. The algorithm categories considered for study are greedy algorithms, dynamic programming, network flow algorithms, graph algorithms, and approximation algorithms.

The goal of this course is to develop the appropriate background, foundation and experience for advanced study in Computer algorithms and their performance. Students will develop the necessary skills from both a theoretical perspective as well as applying their knowledge on various problem solving strategies.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Derive complexity of algorithms using various techniques
CO2	Analyze and solve problems for various problem solving strategies
CO3	Solve path computation and network flow problems using various approaches
CO4	Acquire knowledge of advanced data structures like trees and heaps
CO5	Analyze performance Approximation algorithms over traditional solutions

Module No.	Unit No.	Details of Topic	Hrs.	CO
1		**Introduction to analysis of Algorithms**		CO 1
	1.1	Design and Analysis Fundamentals, Performance analysis, space and time complexity.	04	
	1.2	Algorithm analysis and Problem Solving: Master's theorem, Substitution method		
2		**Algorithmic strategies for problem solving**		CO 2
	2.1	Comparison of algorithmic strategies: Divide and Conquer, Greedy strategy, Dynamic Algorithms, backtracking, branch and bound.	06	
	2.2	Demonstrate best algorithmic strategy for Traveling Salesman problem (greedy, dynamic, backtracking, branch and bound), Knapsack problem (greedy, dynamic, backtracking, branch and bound)		
3		**Graph Algorithms**		CO 3
	3.1	Johnson's method for shortest path in graphs	06	
	3.2	Flow Networks in Graphs: The Ford Fulkerson method, Push relabel algorithms, The relabel to front algorithm		
4		**Advanced Data Structures**		CO 4
	4.1	Introduction to trees and heap Red-Black Trees: properties of red-black trees ,Operations on Red-black trees	06	
	4.2	Binomial Heaps: Binomial trees and binomial heaps, Operation on Binomial heaps		
	4.3	Applications of advanced data structures		
5		**Approximation Algorithms**		CO 5
	5.1	P, NP, NP Complete, NP HARD complexity classes, Reduction method for NP class problems to NP Complete class	08	
	5.2	Approximation Algorithms: The vertex cover problem, The set covering problem, The traveling salesman problem, sum of subsets problem.		
		Total	**30**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	*Introduction to Algorithms*	PHI, India	Second Edition
2	Rajeev Motwani, Prabhakar Raghavan,	*Randomized Algorithm*	Cambridge University Press	First Edition/ South Asia Edition
3	Peter Norvig and Stuart J. Russell	*Artificial Intelligence: A Modern Approach*	Pearson Education	5th Edition
4	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein,	*Introduction to Algorithms*	PHI	2nd Edition
5	Horowitz, Sahani and Rajsekaran	*Fundamentals of Computer Algorithms*	Galgotia	2nd Edition
6	Harsh Bhasin,	*Algorithms – Design and Analysis‖,*	Oxford	1st Edition, 2015

Course Code	Course Title						
116U01L852	Advanced Algorithms: Design and Analysis						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "**Advanced Algorithms: Design and Analysis**". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
116U01E853	Internet of Everything						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	02		--		--		02
Credits Assigned	02		--		--		02
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):Microcontroller and Embedded system

Course Objectives

The objectives of this course are to

Learn concepts of Internet of things and analyze IoT application data using Analytics for designing and developing small IOT applications.

Course Outcomes

At the end of successful completion of the course the student will be able to

- **CO1 Interpret the Internet of Things concepts and c challenges**
- **CO2 Evaluate the software and hardware platforms for IoT Technologies**
- **CO3 Analyze IoT application data using IoT Analytics.**
- **CO4 Design and develop small IoT applications.**

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to Internet of Things**	**03**	**CO1**
	1.1 1.2 1.3.	Physical Design Logical Design IoT Enabling Technologies		
2		**Domain Specific IoTs**	**05**	**CO1**
	2.1 2.2 2.3	Home Automation. Environment, Energy Health & Life Style		
3		**IoT & M2M**	**05**	**CO2**
	3.1 3.2	Difference Between IoT & M2M SDN & NFV for IoT		
4		**IoT Physical Devices**	**05**	**CO2**
	4.1 4.2 4.3 4.4	Basic Arduino Programming Arduino – Based Internet Communication, Raspberry PI Sensors and Interfacing.		
5		**IoT design Methodology**	**05**	**CO4**
	5.1 5.2	Generic Design Methodology Application Development Steps		
6		**IOT Analytics**	**05**	**CO3**
	6.1 6.2 6.3	Business Process in IoT IoT Analytics with cloud Edge analytics		
7		**Self-learning :Case Study**	**02**	**CO4**
	7.1 7.2	Agriculture Industrial Application		
		Total	**30**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
6.	Arshdeep Bhaga and Vijay Madisetti	"Internet of Things (A Hands-on-Approach)",University Press	Tata McGraw-Hill ,India	4th edition ,2015
7.	Hakima Chaouchi	"The Internet of Things (Connecting objects to the web)"	Wiley publication	1st edition,2014
8.	Hakim Cassimally and Adrian McEwen	" Designing the Internet of things"	Wiley publication	1st edition,2013
9.	Marina Ruggieri, Homayoun Nikookar,	"Internet of Things - From Research and Innovation to Market"	River Publisher,	1st edition,2014
10.	Ahriram K Vasudevan,Abhishek Nagarajan,RMD Sundaram	Internet of Things	Wiley Publication	1st edition ,2019

Course Code	Course Title						
116U01L853	Internet of Everything						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Internet of Everything". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
116U01E854	Deep Learning						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	02		--		--		02
Credits Assigned	02		--		--		02
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites:

Linear Algebra, Calculus (vectors, matrices, basic integrals), Probability (Bayes theorem, expectation, variance) & basic machine learning (linear models, regression, decision trees).

Course Objectives:

This course covers the basics of machine learning, neural networks and deep learning. Model for deep learning techniques and the various optimization and generalization mechanisms are included. Major topics in deep learning and dimensionality reduction techniques are covered. The objective of this course is:

1. To present the mathematical, statistical and computational challenges of building neural networks
2. To study the concepts of deep learning
3. To introduce dimensionality reduction techniques
4. To enable the students to know deep learning techniques to support real-time applications
5. To examine the case studies of deep learning techniques

Course Outcomes:

At the end of successful completion of the course the student will be able to

1. Use best practices to train and develop test sets and analyze bias/variance, standard neural network techniques & optimization algorithms for building DL applications.
2. Build & analyze CNN architecture and apply it to image detection and recognition tasks.
3. Use and apply unsupervised deep learning models on different applications.
4. Apply & analyze different RNN models on text applications.
5. Understand the concepts of different sequence models & attention mechanisms.

Module No.	Unit No.	Details	Hrs.	CO
Name of the subject: Deep Learning				
1	**Basic machine learning & deep learning concepts**		**05**	**CO1**
	1.1	Introduction to machine learning models.		
	1.2	Intro to Neural Nets: What a shallow network computes- Training a network: loss functions		
	1.3	Back propagation and gradient descent concepts.		
	1.4	Learning rates and data normalization, activation functions, Optimizers, Regularization, Dropout, Momentum & Batch Norm.		
2	**Deep Networks: Convolutional neural network**		**07**	**CO2**
	2.1	History of Deep Learning- A Probabilistic Theory of Deep Learning, Neural Nets-Deep Vs Shallow Networks-		
	2.2	Convolutional Neural Networks: Motivation, Convolution operations, Pooling		
	2.3	Image classification		
	2.4	CNN architectures (VGG, ResNet, etc.)		
3	**Auto encoders**		**06**	**CO3**
	3.1	Autoencoders, Denoising autoencoders & Sparse autoencoders,		
	3.2	Generative Adversarial Network		
4	**Recurrent Neural Networks**		**08**	**CO4**
	4.1	RNN, back propagation through time, different types of RNN & Vanishing/Exploding gradient problem		
	4.2	RNN architectures (LSTM, GRU, etc.)		
	4.3	Word embedding, Word2Vec, negative sampling		
	#Self-Learning: Bi directional RNN & LSTM & GloVe			
5	**Sequence Models**		**04**	**CO5**
	5.1	Basic sequence model – encoder decoder architecture		
	5.2	Beam search concept, Attention Model Intuition & Attention Model.		
	#Self-Learning topic: Applications of Deep Learning to Computer Vision : Image segmentation, object detection, automatic image captioning, video to text with LSTM models			
		Total	**30**	

Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Ian Goodfellow, YoshuaBengio, Aaron Courville	Deep Learning	An MIT Press book	2016
2.	Deng & Yu	Deep Learning: Methods and Applications	Now Publishers	2013
3.	Michael Nielsen	Neural Networks and Deep Learning	Determination Press	2015
4.	Josh Patterson , Adam Gibson	Deep Learning: A Practitioner's Approach	Shroff/O'Reilly	First edition (2017)
5.	Nikhil Buduma, Nicholas Locascio	Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms	O'Reilly Media	First edition (June 29, 2017)

Course Code	Course Title						
116U01L854	Deep Learning						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Deep Learning". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E855	**Business Analytics**							
	TH			**P**		**TUT**		**Total**
Teaching Scheme(Hrs.)	**02**			**--**		**--**		**02**
Credits Assigned	**02**			**--**		**--**		**02**
Examination Scheme	**Marks**							
	CA		**ESE**	**TW**	**O**	**P**	**P&O**	**Total**
	ISE	**IA**						
	30	**20**	**50**	**--**	**--**	**--**	**--**	**100**

Course Prerequisites (if any):
Engineering mathematics and spread sheet

Course Objectives:
1. The course is an introduction to Business Analytics. It covers managerial statistical tools in descriptive analytics and predictive analytics for trend line analysis and forecasting with time series, risk analysis, simulation, and data mining, and decision analysis.
2. This course provides students with the fundamental concepts and tools needed to understand the emerging role of business analytics in organizations and shows students how to apply basic business analytics tools in a environment, and how to communicate with analytics professionals to effectively use and interpret analytic models and results for making better business decision.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1: Understand ad perform Business analytics , Database analytics from a variety of business scenarios
CO2: Applying statistical inference techniques to conduct and interpret result of hypothesis testing
CO3: Use of Trend-lines and Regression analysis to fit models to data
CO4 : Understand forecasting model based on time series
CO5: Apply expected values in making the decision.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to business analytics**		06	CO1
	1.1	Introduction , Evolution ,Types of analytics ,Models, Data for Business analytics , problem solving with Analytics		
	1.2	Basic Excel Skills, Database analytics : Data sets and data bases, Data queries, praetor analysis, data base functions		
2	**Descriptive Analytics**		06	CO2
	Statistical Inference- hypothesis testing- one sample, two sample, Analysis of variance(ANOVA), Chi-square Case study : Customer care			
3	**Predictive Analytics**		06	CO3
	Trend lines and regression analysis: Simple linear regression, multiple linear regression , building regression model, regression model with categorical variables, regression model with Non-linear terms Case study : Revenue management**,**			
4	**Forecasting Techniques**		06	CO4
	Qualitative& Judge mental forecasting, statistical Forecasting models, forecasting models for stationary time series , FM for Time series with a Linear Trend, Forecasting Time series with Seasonality, regression Forecasting with casual variables Case study: Sales Performance			
5	**Decision Analysis**		06	CO5
	Making decisions Objectives, formulating decision problems ,decision strategies without outcome probability, Decision trees, decision with sample information, utility and decision making Case study :Mortgage , Sensitivity analysis			
		Total	30	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	James R. Evans	Business Analytics	Pearson	3rd Edition, 2014
2	Sandhya Kuruganti , Hindol Basu	Business Analytics Applications to consumer Marketing	Mc, Graw Hill Education	1st Edition 2015
3	*Albright , Winston*	*Business Analytics data analysis and decision making*	Cenage	5th Edition 2015

Course Code	Course Title						
116U01L855	Business Analytics						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Business Analytics". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E861	Game Programming							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	02			--		--		02
Credits Assigned	02			--		--		02
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Computer Graphics, Mathematics, Basic Physics, Data Structure and Algorithms

Course Objectives
Understand the concepts of Game design and development. Learn the processes, mechanics and issues in Game Design. Be exposed to the Core architectures of Game Programming. Know about Game programming platforms, frame works and engines.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1 Understand and choose appropriate game architecture
CO2 Design a game using appropriate development environment
CO3 Implement a game with detailed components
CO4 Optimize, debug and publish an ethical games

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to game programing**		04	CO1
	1.1	Game Architecture Applying the Game Architecture Application Layer Game Logic Game View for the Human Player Game Views for AI Agents Networked Game Architecture Design Philosophy of DirectX		
2	**Hardcore Game Programming**		04	CO 2
	2.1	Introduction to Game Design Data Structures and Algorithms for Game Programming The Mathematical Side of Games Introduction to Physics Modeling		
3	**Building Your Game**		07	CO 2
	3.1	Creating a Project Source Code Repositories and Version Control Building the Game: A Black Art? Creating Build Scripts Game Initialization and Shutdown		
4	**Game Actors and Component Architecture and Controlling the Main Loop**		08	CO3
	4.1	Game Actors and Component Architecture A First Attempt at Building Game Actors Component Architecture Creating Actors and Components Defining Actors and Components Storing and Accessing Actors Putting It All Together Data Sharing		
	4.2	Controlling the Main Loop Organizing the Main Loop Playing Nicely with the OS Using the DirectX Can I Make a Game Yet? Creating Game Mission**		
		#Self-Learning : Creating Sound		
5	Loading and Caching , Optimization , Debugging and Publishing		07	CO
	5.1	Loading and Caching Game Data Game Resources: Formats and Storage Requirements Resource Files The Resource Cache Out of Cache		
	5.3	Optimization and Debugging The Art of Handling Failure Debugging Basics Graphics and Shader Debugging		

		Debugging Techniques Building an Error Logging System. Different Kinds of Bugs Profiling Game Publishing		
	5.3	Game engine, Game Server and Client		
	5.4	The Ethics of Computer Games Applying Ethics Unethical Game Content and Effect Studies The Ethics of Game Design		
		#Self-learning : Case Studies: Ethical and Unethical games		
		Total	**30**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Mike “MrMike” McShaffry and David “Rez” Graham	*Game Coding Complete*	Cengage Learning. USA	Fourth Edition 2013
2.	André LaMoth	*Game Programming All in One*	Premier Press, Inc, USA	Second Edition , 2002

Course Code	Course Title						
116U01L861	Game Programming						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Game Programming". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
116U01E862	**IoT Security**						
	TH		P	TUT	Total		
Teaching Scheme (Hrs.)	03		--	--	03		
Credits Assigned	03		--	--	03		
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course Prerequisites (if any):
Microcontroller and embedded system, Security

Course Objectives:
To expose students to new developments in the areas of cybersecurity for the Internet of Things (IoT).

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1 Understand IoT background in terms of applications and challenges.
CO2 Analyze possible approaches and practices to meet IoT security challenges.
CO3 Comprehend proposed frameworks to address IoT security.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to IoT**		**08**	**CO1**
	1.1	The Internet of Things Today and Tomorrow		
	1.2	Characteristics of IoT		
	1.3	IoT Layered Architecture		
	1.4	IoT Function View		
	1.5	IoT Application Areas and IoT Smart-X Applications		
	1.6	Security, Privacy and Trust		
2	**IoT challenges**		**06**	**CO1**
	2.1	IoT Threats to Individuals and Organizations		
	2.2	IoT challenges for Governance, Security and Privacy		
	2.3	Challenges to Secure IoT Deployments		
		#Self-Learning –Readings: Internet of Things – New security and privacy challenges-Paper by Rolf H. Weber		
3	**Recommended Security Approaches**		**06**	**CO2**
	3.1	Analyze privacy impacts to stakeholders and adopt a Privacy-by-Design approach to IoT development and deployment.		
	3.2	Threat Modeling		
	3.3	Implement layered security protections to defend IoT assets		
	3.4	Define Life Cycle Security Controls for IoT devices		
		#Self-Learning – Readings: IoT System Security Issues and Solution Approaches (Paper)		
4	**Implement data protection best practices to protect sensitive information**		**02**	**CO3**
	4.1	Data Management.		
	4.2	Data Identification, Classification, Security		
		#Self-Learning- Readings: Security of Smart Objects in IOT		
5	**IoT Security Framework**		**05**	**CO3**
	5.1	Dynamic Context- Aware Scalable and trust-based IoT Security, Privacy Framework- Concepts and Motivation of Framework		
	5.2	A Policy-based Framework for Security and Privacy in IoT		
	5.3	An authentication/authorization framework for the organization's IoT Deployments		
	5.4	A Logging and Audit Framework for the Organization's IoT Ecosystem		

6	**OWASP – IoT**		**03**	**CO3**
	6.1	OWASP IoT Top Ten Attacks, IoT Vulnerabilities		
	6.2	IoT Framework assessment		
	6.3	IoT Security Guidance		
		Total	**30**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Marina Ruggieri, Homayoun Nikookar,	"Internet of Things - From Research and Innovation to Market"	River Publisher,	2014
2.	Sebastien Ziegler	"Internet of Things security and data protection"	Springer	2017
3.	Shancang Li, Li Da Xu	"Securing the Internet of Things"	Syngress	April 2015
4.	Sridipta Misra, Salman Hashmi, Muthucumaru Maheswaran	Security Challenges and Approaches in Internet of Things	Springer	Sept 2016
5.	Sunil Cheruvu, Ned Smith, Anil Kumar, David M. Wheeler	Demystifying Internet of Things Security: Successful IoT Device/Edge and Platform Security Deployment	Apress Open	August 2019

Course Code	Course Title						
116U01L862	IoT Security						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "IoT Security". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
116U01E863	Cyber Physical System						
	TH		P	TUT	Total		
Teaching Scheme(Hrs.)	02		--	--	02		
Credits Assigned	02		--	--	02		
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course Objectives

CPS mainly consists of physical systems tightly integrated and/or controlled by software, are ubiquitous in many safety critical domains, including automotive, avionics, railways, healthcare, atomic energy, power, and industrial automation. The principles of design and implementation of cyber-physical systems are remarkably different from that of other embedded systems because of the tight integration of real valued and dense time real time systems with software based discrete automated control. The objective of this course is to develop an exposition of the challenges in implementing a cyber-physical system from a computational perspective, but based equally on the principles of automated control. The course aims to expose the student to real world problems in this domain and provide a walk through the design and validation problems for such systems.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1 Understand the basic principles of CPS
CO2 Identify the CPS components and relevant dynamical aspects
CO3 Develop an exposition of the challenges in implementing a cyber-physical system
CO4 Understand Intelligent CPS models and controls
CO5 Understand CPS security and safety aspects

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Cyber-Physical Systems**		4	CO1
	1.1	Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS.		
2	**CPS Components**		8	CO2
	2.1	**CPS - Platform components** – CPS HW platforms - Processors and Its Types, Sensors:- Types & Working Principle, Actuators- Hydraulic, Neumatic, Pneumatic and Electrical, CPS Network - HART, WirelessHart, CAN, Automotive Ethernet,		

		Scheduling Real Time CPS tasks-Fixed & Dynamic Priority Assignments.		
	2.2	**Principles of Dynamical Systems-** Controller Design Techniques:- Without Feedback, With - Feedback Control, Proportional Feedback control:- Feedback control of Wire plant , Operational Amplifiers, Constant gain plants, Dynamical Systems and Stability, Multidimensional Error and Proportional/Integral/Differential Feedback Control, Performance under Packet drop and Noise.		
3	**CPS implementation issues**		**7**	**CO3**
	3.1	From features to automotive software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, BUilding real-time networks for CPS		
4	**Intelligent CPS**		**6**	**CO4**
	4.1	Safe Reinforcement Learning- Robot motion control, Autonomous Vehicle control, Gaussian Process Learning- Smart Grid Demand Response, Building Automation		
5	**Secure Deployment of CPS**		**5**	**CO5**
	5.1	Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study : Vehicle ABS hacking, Power Distribution Case study : Attacks on SmartGrids		
		#Self-Learning: Latest trends in CPS, Securing CPS systems using ML		
		Total	**30**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.
Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	E. A. Lee, Sanjit Seshia	Introduction to Embedded Systems – A Cyber–Physical Systems Approach	MIT Press	2nd Edition, 2017
2.	Rajeev Alur	Principles of Cyber-Physical Systems	MIT Press	Kindle Edition , 2015
3.	Andr´e Platzer	Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics	Springer	Kindle Edition, 2010

4.	Houbing Song, Danda B. Rawat, Sabina Jeschke, Christian Brecher	Cyber-Physical Systems: Foundations, Principles and Applications	Academic Press	1st Edition, 2016
5.	Houbing Song, Glenn A. Fink, Sabina Jeschke	Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications	Wiley-IEEE Press	1st Edition, 2017
6.	Walid M. Taha. Abd-Elhamid M.Taha John Thunberg	Cyber Physical System -A Model based Approach	Springer	1st Edition, 2021

Course Code	Course Title						
116U01L863	Cyber Physical System						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Cyber Physical System". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
116U01E864	**Natural Language Processing**						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	02		--		--		02
Credits Assigned	02		--		--		02
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	25	25	--	--	150

Course Prerequisites (if any):
theory of computer science, probability theory, machine learning concepts & basic python programming.

Course Objectives:
This course starts with the basics of text processing including basic pre-processing, spelling correction, language modeling, Part-of-Speech tagging, Constituency, Lexical Semantics, distributional semantics and topic models. Finally, the course also covers some of the most interesting applications of NLP such as information extraction, topic modeling, text summarization & sentiment analysis

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1: Learn the fundamentals of natural language processing
CO2: Understand and explore the use of language modeling, POS tagging in NLP.
CO3: Understand & apply syntax analysis in NLP.
CO4: Understand the role of distributional and lexical semantics in NLP.
CO5: Apply NLP techniques to design real world NLP applications.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to NLP & basic text processing:**		5	CO1
	1.1	NLP introduction, levels, ambiguity in natural language, stages in NLP, challenges of NLP and empirical laws in NLP.		
	1.2	Basic text processing: tokenization, sentence segmentation, lemmatization, Porter stemmer algorithm for stemming and Zipf's law.		
	1.3	One hot encoding, tfidf and computational morphology concepts.		
2	**Word level analysis & Language Modelling:**		5	CO2
	2.1	Edit Distance in spelling correction, weighted edit distance, noisy channel model for spelling correction.		
	2.2	N-Gram language models, evaluation of language models and basic smoothing.		
	2.3	Part of speech tagging problem, Tag set for English (Penn Treebank) and hidden markov model for POS tagging.		
3	**Syntax analysis**		6	CO3
	3.1	Syntax – Introduction, Constituency, Constituent Phrases & Context free grammar.		
	3.2	Parsing, parse tree, top down & bottom up parsing, Dynamic programming, CKY algorithm & PCFGs. Self-learning: Attachment for fragment of English- sentences, noun phrases, Verb phrases and prepositional phrases.		
4	**Distributional & Lexical Semantics:**		7	CO4
	4.1	What is semantics, computational semantics? The distributional semantic (Vector space) model, Constructing Word spaces, distributional vectors.		
	4.2	Word vectors, word2vec - a distributed representation, word embedding, learning word vectors CBOW & skip gram models.		
	4.3	Lexical semantics: Relations among lexemes & their senses, WordNet, word sense disambiguation – dictionary based approaches - lesk, walker algorithm & machine learning based approaches. Self – learning: Doc2Vec, BERT & GloVe word embedding techniques.		
5	**Discourse Analysis & NLP applications:**		7	CO5
	5.1	Concept of coherence, discourse structure, discourse segmentation, text coherence and reference resolution.		
	5.2	Applications: Topic modelling, question answering, machine translation, summarization, sentiment analysis.		
		Total	30	

Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Daniel Jurafsky, James H. Martin	Speech and Language Processing	Prentice Hall	Second Edition, 2008
2.	Christopher D.Manning and HinrichSchutze	Foundations of StatisticalNatural Language Processing	MIT Press	1999
3.	Siddiqui and TiwaryU.S.	Natural Language Processing and Information Retrieval	Oxford University Press	2008
4.	Bodhisattwa Majumder; Anuj Gupta; Sowmya Vajjala; Harshit SuranaPublished	Practical Natural Language Processing	O'Reilly Media, Inc	2020
5.	Dipanjan Sarkar	Text Analytics with Python: A Practitioner's Guide to Natural Language Processing	Apress publisher	2019

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus. Term Work will consist of Practical covering entire syllabus of 'Natural Language Processing'. Students will be graded based on continuous assessment of their term work. Practical which will demonstrate the Natural Language Processing concepts

Course Code	Course Title						
116U01L864	Natural Language Processing						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Natural Language Processing". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E865	**High Performance Computing**							
	TH			**P**		**TUT**		**Total**
Teaching Scheme(Hrs.)	**02**			**02**		**--**		**04**
Credits Assigned	**02**			**01**		**--**		**03**
Examination Scheme	**Marks**							
	CA		**ESE**	**TW**	**O**	**P**	**P&O**	**Total**
	ISE	**IA**						
	30	**20**	**50**	**25**	**25**	**--**	**--**	**150**

Course prerequisites (if any): Microprocessor and Fundamentals of computer programming

Course Objectives

Purpose of this course is to study parallel architectures and Design and Development of parallel algorithms and programs. This course introduces parallel programming paradigms using tools like MPICH and OpenMP and multicore program approaches using CUDA platform.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Understand different parallel processing approaches and issues involved in it to achieve high computing performance.
CO2	Evaluate the parallel computing performance with different processors architectures.
CO3	Design and development on parallel platform.

Module No.	Unit No.	Details	Hrs.	CO
		Parallel processing approaches		**CO1**
1			**08**	
	1.1	Introduction to parallel processing: Levels of parallelism (instruction, transaction, task, thread, memory, and function).		
	1.2	Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models and Demand-driven Computation etc).		
	1.3	Parallel platforms: Message-passing interface (MPI), Shared-memory thread-based OpenMP programs, and hybrid (MPI/OpenMP) programs, Hadoop, Cloud computing, Multi-core Processors (GPUs),Virtual GPUs, Field programmable gate array(FPGA), Tensor Processing Unit (TPU)		
2	**Fundamental Design Issues and limitations in Parallel Computing**		**08**	**CO1**
	2.1	Issues: Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis.		
	2.2	Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms.		
	2.3	Limitations: Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations.		
3	**CUDA : GPU Parallel development environment**			**CO2**
	3.1	**C**ompute Unified Device Architecture **(**CUDA) Architecture, CUDA programming model, execution model.		
	3.2	Thread organization: Concept of grid, block and thread.		
	3.3	Thread index generation, warp;		
4	**GPU primitives, algorithms and applications**		**08**	**CO2**
	4.1	GPU primitives: scan (exclusive or inclusive), scatter, gather, reduce, memory model.		
	4.2	Introduction to global, shared, local memories, usage of cache, texture cache, constant memory.		
	4.3	CUDA structure, API and library (CUDPP, CUBLAS, FFT etc.) details.		
5	**GPU parallel programming and application**		**06**	**CO3**
	5.1	CUDA example programs (Vector dot product, Matrix multiplication (with the usage of tiling and shared memory) etc.		
	5.2	Graph algorithms, molecular dynamics, n-body simulations, dense linear algebra etc. using GPU. Virtual GPUs.		
		#Self-Learning: Tensor Processing Unit (TPU), Application of AI in HPC		
		Total	**30**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Kai Hwang , Faye A. Briggs	Computer Architecture and Parallel Processing	McGraw-Hill	
2.	Edward Kandrot and Jason Sanders	CUDA by Example: An Introduction to General-Purpose GPU Programming	Addison-Wesley Professional	2010
3.	Alex Holmes	Hadoop in Practice	Manning Press, Dream tech Press	
4.	David Kirk, Wen-mei	UDA: Programming Massively Parallel Processors: A Hands-On Approach Hwu	ELSEVIER Inc	
5.	Michael J. Quinn	Parallel Programming in C with MPI and OpenMP	Tata McGraw-Hill Edition	
6.	Kai Hwang	Scalable Parallel Computing	McGraw Hill	1998
7.	Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar	Introduction to Parallel Computing	Addison-Welsey,	2nd edition, 2003

Course Code	Course Title						
116U01L865	High Performance Computing						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "High Performance Computing". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title							
116U01E866	Blockchain Architecture and Application Development							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	02			--		--		02
Credits Assigned	02			--		--		02
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites:

- Basic of Blockchain
- Networking Concepts,
- Object Oriented Programming Skills,
- Cryptography
- Network Security Concepts.

Course Objectives:

The objective of this course is to provide conceptual understanding of how block chain technology can be used to innovate and improve business processes. The course covers the technological underpinning of block Chain operations in both theoretical and practical implementation of solutions using block Chain technology.

Course Outcomes:

CO1 Develop applications in Solidity language & Multiple Technology-based developments.
CO2 Develop block chain based solutions and write smart contract using Hyperledger Fabric and Ethereum frameworks.
CO3 Illustrate in-depth understanding of Blockchain, Smart Contracts & it's working
CO4 Integrate ideas from various domains and implement them using block chain technology in different perspectives.
CO5 Use Block chain Technology for Enterprise applications

Module No.	Unit No.	Details	Hrs.	CO
1	**Smart Contract Development and Deployment**		12	CO2 CO3
	1.1	Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts.		
	1.2	**Programming for Blockchain:** Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling.		
2	**Go Ethereum**		04	CO1
	2.1	Introduction to Go Ethereum (Geth), Geth Installation and Geth CLI, Setting up a Private Ethereum Blockchain. **Introduction to Truffle**: Smart Contract deployment on a Private Blockchain. Introduction to Ganache.		
3	**Enterprises Blockchain**		10	CO2 CO5
	3.1	**Hyperledger Fabric Chaincode:** Chaincode, Gradle, Chaincode Development Chaincode Package, Install, Approve.		
	3.2	**Multichain:** Introduction to Multichain, Multichain Installation, Create a Multichain Instance, Multichain Assets, Multichain Streams, Multichain Consensus, Multichain API.		
4	**Use Cases**		4	CO4
	4.1	1. Setup Hyperledger Fabric. 2. Set up Multichain in the Local Machine. 3. Create a Private Multichain Blockchain.		
		Total	30	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
4.	Andreas M. Antonopoulos	Mastering the Bitcoin: Programming the Open Blockchain	O' Reilly	2nd Edition, 2017
5.	Melanie Swan	Blockchain	O'Reilly	2015
6.	Nitin Gaur, Luc Desrosiers, Petr Novotny, Venkatraman Ramakrishna	Hands-On Blockchain with Hyperledger: Building decentralized applications with Hyperledger Fabric and Composer	Packt	Kindle Edition, 2018
4.	*Stephen Fleming business ecosystems*	*Blockchain Technology: Introduction to Blockchain Technology and its impact on*	Stephen Fleming	2017
5.	*Zeeshan-ul- hassan Usmani*	*Introduction to lockchain with Case Studies*	Guhftgu Publication	2018

Course Code	Course Title						
116U01L866	Blockchain Architecture and Application Development						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	--	--	--	25	25	--	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Blockchain Architecture and Application Development". Students will be graded based on continuous assessment of their term work.