



SOMAIYA
VIDYAVIHAR UNIVERSITY

K J Somaiya College of Engineering

Syllabus

LY B.Tech Electronics and Computer Engineering
(Last Year: Semester VII-VIII)

From
Academic Year 2025-26
(Revision-1)

LY B.Tech /EXCP/Revision 1.0



K.J. Somaiya College of Engineering, Mumbai-77
(Somaiya Vidyavihar University)

It is notified for information of all concerned that the Board of Studies at its meeting held on 21/04/2025 and the subsequent meeting of the Faculty of Engineering and Technology (FoET) on 22/04/2025 and Academic Council held on 28/04/2025 amended the syllabus of L.Y. B. Tech EXCP. Same will be brought into force from Academic Year 2025-26 with immediate effect.

Preamble

The Department was established in 1983 and has been accredited thrice by the National Board of Accreditation in 1998, 2009, and 2013. The Department offers UG, PG, and Ph.D. programs. In the era of Industry 4.0, intelligent devices are an integral part of human life. This has resulted in the need for electronics engineers to acquire skill of hardware design and System Software so that they can effectively use their expertise in the domains which are combination of hardware - software; such as Embedded Systems, Robotics, IOT, Machine Vision, Data Analytics, and Artificial intelligence.

Due to the rapid evolution in all the above fields, engineers must possess proficiency in hardware and software. Electronics and Computer engineering aims to integrate two separate engineering domains, exposing the students to the needs of today's industry. It is necessary to map industry requirements into the educational system and develop a continuous knowledge cycle that gives exposure to new technologies. Industrial automation is an interdisciplinary topic covering areas ranging from algorithms to handling processes and system developments to digital manufacturing. By increasing automation through the use of sensors, IoT, and configurable robots on the assembly line, 'smart' factories will be able to mass-produce items satisfying individual customer orders and specifications. Efficiency in productivity and quality of the product can be improved through automation and Internet-of-Things (IoT). The Department strives to provide a conducive environment for the students to develop analytical and practical skills and apply them to real-world problems.

The major emphasis of the curriculum is:

- To prepare the Learner with a sound foundation in the mathematical, scientific, and engineering fundamentals.
- To motivate the Learner in the art of self-learning and to use modern tools for solving real-life problems.
- To equip the learners with the skill set of Laboratory tools by including various laboratory courses in the curriculum.
- To equip the Learner with state-of-the-art programming languages to make them ready for placements.
- Our core courses are designed in a manner to prepare the Learner to be equally competent for qualifying competitive technical examinations.
- To encourage, motivate, and prepare the Learner for Lifelong- learning.
- To ingrain in the learner's mind the values of professionalism, ethics, effective leadership, and social responsibility.

HOD ETRX

Vision

To impart excellent quality-education by keeping pace with rapidly changing technologies and to create technical manpower of global standards with ethical and social values.

Mission

Efforts to impart quality and value-based education to:

- Raise satisfaction level of all stakeholders
- Create competent professionals
- Provide all possible support to promote research and development activities

Program Educational Objectives (PEOs)

A graduate of Electronics and Computer Engineering will:

- PEO 1. Adapt to upcoming technologies to solve real-life problems of society
PEO 2. Pursue higher education or research, demonstrate entrepreneurial qualities
PEO 3. Emerge as a leader with a professional and ethical outlook, exhibit effective communication, teamwork and multidisciplinary approach

Program Outcomes (POs)

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

- PO 1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO 2. **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.
- PO 3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety and the cultural, societal, and environmental considerations.
- PO 4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and inter-

- interpretation of data, and synthesis of the information to provide valid conclusions.
- PO 5. **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.
- PO 6. **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.
- PO 7. **Multidisciplinary competence:** Recognize/ study/analyze/provide solutions to real-life problems of multidisciplinary nature from diverse fields
- PO 8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO 9. **Individual and teamwork:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
- PO 10. **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.
- PO 11. **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.
- PO 12. **Lifelong 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 (PSOs)

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

- PSO 1. Design, construct and implement hardware and software based modern Electronic systems with varying complexities specialization to the solution of complex engineering problems.
- PSO 2. Demonstrate proficiency in use of software and hardware required in real-life applications.

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

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Semester VII - Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH-P-TUT	Total Hrs.	Credits As-signed TH-P-TUT	Total Credits	Course Category
116U40C701	Artificial Intelligence and Machine Learning	3-0-0	03	3-0-0	03	PC
116U40E71X	Department Elective - III	3-0-0	03	3-0-0	03	PE
116U40E72X	Department Elective - IV	3-0-0	03	3-0-0	03	PE
116U06O7XX	Open Elective Technical – III / Online SWAYAM / Coursera Course	3-0-0	03	2-0-0	02	OE
116U40P701	Project – I*	0-8-0	08	0-4-0	04	PR
116U40L701	Artificial Intelligence and Machine Learning Laboratory	0-2-0	02	0-1-0	01	PC
116U40L71X	Department Elective - III Laboratory	0-2-0	02	0-1-0	01	PE
116U40L72X	Department Elective - IV Laboratory	0-2-0	02	0-1-0	01	PE
TOTAL		12-14-0	26	11-7-0	18	

*For students opting for Semester Long Internship in Sem VIII, Project I will not continue to Project II

Semester VII - Department Elective -III

Course Code	Elective III Name	Course Code	Elective IV Name
116U40E711 116U40L711	Embedded System Design	116U40E721 116U40L721	Advanced Databases and Data Warehousing
116U40E712 116U40L712	Industrial Product Design	116U40E722 116U40L722	Cloud Computing Architecture
116U40E713 116U40L713	Integrated Circuit Technology	116U40E723 116U40L723	C# Programming and .NET Technology ^{&}
116U40E714 116U40L714	Multirate and Wavelet Transform	116U40E724 116U40L724	Foundation of Machine Learning and Pattern Recognition
116U40E715 116U40L715	Power Electronics and Drives	116U40E725 116U40L725	Information and Cyber Security
116U40E716 116U40L716	Robotics and Computer Vision	116U40E726 116U40L726	Software Testing and Quality Assurance

[&] ISE and ESE based on PR exam.

Semester VII - Examination Scheme

Course Category	Course Name	CA		ESE	TW	O*	P&O	Total
ISE	IA							
116U40C701	Artificial Intelligence and Machine Learning	30	20	50	-	-	-	100
116U40E71X	Department Elective - III	30	20	50	-	-	-	100
116U40E72X	Department Elective - IV	30	20	50	-	-	-	100
116U06O7XX	Open Elective Technical – III / Online SWAYAM / Coursera Course	30	20	-	-	-	-	50
116U40P701	Project – I*	-	-	-	25	25	-	50
116U40L701	Artificial Intelligence and Machine Learning Laboratory	-	-	-	25	25	-	50
116U40L71X	Department Elective - III Laboratory	-	-	-	25	25	-	50
116U40L72X	Department Elective - IV Laboratory	-	-	-	25	25	-	50
TOTAL		120	80	150	100	100	-	550

*For students opting for Semester Long Internship in Sem VIII, Project I will not continue to Project II

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Semester VIII - Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH-P-TUT	Total Hrs.	Credits As-signed TH-P-TUT	Total Credits	Course Category
116U40E81X	Department Elective -V	2-0-0	02	2-0-0	02	PE
116U40E82X	Department Elective - VI	2-0-0	02	2-0-0	02	PE
116U40P801	Project II	0-16-0	16	0-8-0	08	PR
116U40L81x	Department Elective -V Laboratory	0-2-0	02	0-1-0	01	PE
116U40L82x	Department Elective -VI Laboratory	0-2-0	02	0-1-0	01	PE
TOTAL		4-20-0	24	4-10-0	14	

Semester VIII - Credit Scheme for Sem Long Internship

Course Code	Course Name	Teaching Scheme (Hrs.) TH-P-TUT	Total Hrs.	Credits As-signed TH-P-TUT	Total Credits	Course Category
116U40H801	Semester Long Internship	-	-	-	11	PR
116U40E83X	Elective Online(SWAYAM-NPTEL/ Coursera)	-	-	-	3	
TOTAL		-	-	-	14	

Semester VIII - Department Electives

Course Code	Elective V Name	Course Code	Elective VI Name
116U40E811 116U40L811	Artificial Intelligence Based Wireless Network Design	116U40E821 116U40L821	Big Data Analytics
116U40E812 116U40L812	Deep Learning and Automation	116U40E822 116U40L822	Business Analytics
116U40E813 116U40L813	High Performance Computing	116U40E823 116U40L823	IoT Security
116U40E814 116U40L814	Speech Processing using Machine Learning	116U40E824 116U40L824	Introduction to Cryptography and Network Security
116U40E815 116U40L815	Wireless Sensor Networks and IoT	116U40E825 116U40L825	Natural Language Processing
116U40E816 116U40L816	Block Chain Technology	116U40E826 116U40L826	Real Time Operating System

Semester VIII - Examination Scheme

Course Category	Course Name	ISE	CA IA	ESE	TW	O*	P&O	Total
116U40E81X	Department Elective –V	30	20	50	-	-	-	100
116U40E82X	Department Elective – VI	30	20	50	-	-	-	100
116U40P801	Project II	-	-	-	100	100	-	200
116U40L81x	Department Elective –V Laboratory	-	-	-	25	25	-	50
116U40L82x	Department Elective –VI Laboratory	-	-	-	25	25	-	50
TOTAL		60	40	100	150	150	-	500

Semester VIII - Sem Long Internship Examination Scheme

Course Category	Course Name	ISE	CA IA	ESE	TW	O*	P&O	Total
116U40H801	Semester Long Internship	@150	-	*250	-	-	-	400
116U40E83X	Elective Online(SWAYAM- NPTEL/ Cours-era)	-	-	-	-	-	-	-
TOTAL		150	-	250	-	-	-	400

ISE: - In Semester Evaluation

@ To be conducted by a pair of Internal Examiners approved by department

ESE: End Semester Evaluation

***200 marks for presentation/ examination conducted by internal examiner and Industry expert approved by department and 50 marks will be given on Industry Feedback evaluation**

Course Code	Course Title							
116U40C701	Artificial Intelligence and Machine 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
	ISE	IA	50	—	—	—	—	100

Course prerequisites:

Python Programming, Basics of Linear Algebra

Course Objectives:

This course provides a comprehensive understanding of AI and ML, covering their history, core concepts, and applications. Students will differentiate between AI, ML, and deep learning, explore neural networks, linear regression and classification techniques, and learn model evaluation metrics. Advanced topics include decision trees, random forests, Naive Bayes, Support Vector Machines, clustering, and deep learning with CNNs, RNNs, and GANs. By the end, students will have the skills to analyze data, build models, and excel in AI and ML.

Course Outcomes:

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

- CO 1. Define and explain the fundamental concepts, scope, and types of Artificial Intelligence and Machine learning.
- CO 2. Describe & implement AI Search and optimization techniques.
- CO 3. Differentiate between types of machine learning and implement supervised and unsupervised learning
- CO 4. Implement Deep learning and evaluate the performance using various model evaluation techniques.
- CO 5. Demonstrate understanding of AI/ML deployment techniques.

Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to AI and ML		07	CO1
	1.1	Introduction to AI, definition, scope, types of AI: Narrow, General, and Super AI, Intelligent Agents: PEAS, environment types, and problem solving in AI.		
	1.2	Basic Components and Key Terminology of Machine Learning, Data types, training and testing, activation function, overfitting and under fitting, Bias-variance Tradeoff.		
		Self learning: Self-learning Ethics		
2	AI search and Optimization Techniques		10	CO4
	2.1	AI Search: Types of search, Uninformed (Blind) Search, Breadth-First Search (BFS), Depth-First Search (DFS), Uniform Cost Search (UCS), Informed (Heuristic) Search, Greedy Best-First Search, A* Search, Local Search Algorithms, Hill Climbing, Simulated Annealing, Beam Search, Genetic Algorithms.		
	2.2	Optimization Techniques in AI: Deterministic Optimization, Linear Programming Optimization, Integer Programming; Stochastic Optimization; Simulated Annealing, Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Swarm intelligence-based optimization, Comparison of Search vs. Optimization.		
		Self learning: Open-Source Tools for AI Search & Optimization like AIMA-Python, Pathfinding.js / Pathfinding Python, DEAP, GitHub		
3	Machine Learning		12	CO2
	3.1	Types of ML: Supervised, Unsupervised, semi supervised and Reinforcement learning, Supervised learning: Linear/Logistic Regression, Decision Trees, basics of Neural Networks: Perceptron, MLP, Back propagation, Support Vector Machines (SVM): RBF, Hyperplane, margin, cost function and gradient descent, SVM kernels.		

	3.2	Unsupervised learning: K-Means clustering, Self-Organizing Maps (SOM). Gaussian Mixture Models (GMM). Dimensionality reduction algorithms PCA (Principal Component Analysis)		
		Self learning: Essential machine learning Tools: Scikit-learn, Pandas, and Matplotlib for data analysis and model building		
4	Deep Learning			10
	4.1	Deep Learning: Convolutional Neural Networks (CNN): Architecture, Convolution, Pooling, Recurrent Neural Networks (RNN): Architecture, Vanishing Gradient Problem, concept of Optimizers (SGD, Adam)		CO3
	4.2	Model evaluation metrics : Metrics for Classification Problems: Accuracy, Precision, Recall, F1 Score, area under the Receiver Operating Characteristic (ROC), Confusion Matrix, Metrics for Regression Problems: Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), R-Squared (R^2), Metrics for Clustering Problems: Silhouette Score, Davies-Bouldin Index, Metrics for Anomaly Detection: Precision-Recall AUC, F1-Score (for imbalanced data).		
		Self learning: Frameworks: Explore major deep learning frameworks like Tensor Flow, Keras, and PyTorch for model development		
3	Advancement in AI & ML			06
	5.1	AI deployment techniques on cloud platforms (AWS, GCP), using APIs.		CO5
	5.2	Future of AI & ML: Trends, AGI, AI in society applications: Agriculture, Health care and autonomous systems.		
	Total Hours			45

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1.	Stuart Russell and Peter Norvig	<i>Artificial Intelligence: A Modern Approach</i>	Pearson (United States)	4 th Edition, 2020
2.	Christopher M. Bishop	<i>Pattern Recognition and Machine Learning</i>	Springer (United States)	1 st Edition, 2006
3.	Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining	<i>Introduction to Linear Regression Analysis</i>	Wiley (United States)	5 th Edition, 2012
4.	Ian Goodfellow, Yoshua Bengio, Aaron Courville	<i>Deep Learning</i>	MIT Press (United States)	1 st Edition, 2016
5.	Rajalingappaa Shanmugamani	<i>Deep Learning for Computer Vision</i>	Packt Publishing (United Kingdom)	1 st Edition, 2018
6.	David Foster	<i>Generative Deep Learning</i>	O'Reilly Media (United States)	1 st Edition, 2019
7.	Online Resources: Coursera, edX, Fast.ai, Kaggle and official documentation of TensorFlow, PyTorch, Scikit-learn.			

Course Code	Course Title							
	Embedded System Design							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	03	00	00	03				
Credits Assigned	03	00	00	03				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA	50	—	—	P	P&O	Total
	30	20				—	—	100

Course prerequisites:

Digital Electronics, Electronic Circuits, Microcontrollers and Peripherals.

Course Objectives:

This course provides an introduction to the design and development of embedded hardware and software. It describes features available in modern microcontrollers and their importance in embedded systems. The course covers embedded application development aspects with real-time operating systems and includes case studies for embedded applications.

Course Outcomes:

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

- CO 1. Understand scope, requirements, and general design methodology of embedded systems.
- CO 2. Explain the use of basic features of microcontrollers in embedded systems.
- CO 3. Develop a small system with programming peripherals on micro-controllers.
- CO 4. Describe concepts of Real-Time Operating Systems.
- CO 5. Apply hardware and software knowledge to develop embedded system applications according to requirements and constraints.

Module No.	Unit No.	Details	Hrs.	CO
1	Fundamentals of Embedded System		08	CO1
	1.1	Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal), Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power-supply (Battery technology, Solar), PCB and Passive components, Safety, and reliability, environmental issues, Ethical practice.		
	1.2	Characteristics and quality attributes (Design Metric) of embedded systems. Real-time system's requirements, real-time issues.		
2	Embedded Hardware Concepts		12	CO2
	2.1	Memory allocation and usage, RISC architecture features, System control functions such as Reset, External Interrupt Inputs, interrupt latency, Nested Vectored Interrupt Controller, clocking, and power control functions, General Purpose Input/Output (GPIO), Timer features.		
	2.2	Serial communication standards like SPI, SCI (RS232, RS485), I2C, CAN, USB.		
3	Embedded C programming for Applications using peripherals		10	CO3
	3.1	Overview of data types, bit manipulations operations, preprocessors, functions, etc in Embedded C programming. Use of pointers, arrays, and various data structures in embedded coding.		
	3.2	Interfacing basics GPIO, ADC, PWM, UART, with programming, I/O Operations like keypad, display, LCD interface, implementing timer applications with interrupts.		

4	Introduction to Real time operating system			09	CO4
	4.1	Need for RTOS in Embedded system software, Foreground/Background systems, POSIX Compliance, multitasking, context switching, Scheduler policies for periodic and aperiodic tasks, Architecture of kernel, task scheduler, ISR, IPC tools Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS.			
	Embedded System Modeling and Design Case Studies			06	CO5
5	5.1	UML, Embedded Product development life cycle, Requirement analysis, Hardware block diagram, System model (like FSM, UML), Software architectures (modules, drivers), and Component/hardware selection, covering following cases: Digital Clock, Battery operated Smartcard reader, Automatic Meter Reading System, Digital Camera, Car cruise control, Embedded web server.			
Total			45	—	

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1	Raj Kamal	<i>Embedded Systems</i>	Tata McGraw Hill	Third Edition, 2017
2	Shibu K. V.	<i>Introduction to Embedded Systems</i>	McGraw Hill India Pvt. Ltd	Second Edition, 2017
3	Rajib Mall	<i>Real Time Systems: Theory and Practice</i>	Pearson Education	Second Edition, 2008
4	David K. Simon	<i>An Embedded Software Primer</i>	Pearson Education	First Edition, 2002

Course Code	Course Title						
116U40E712	Industrial Product Design						
	TH	P	TUT	Total			
Teaching Scheme (Hrs.)	03	—	—	03			
Credits Assigned	03	—	—	03			
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	50	—	—	—	100

Course prerequisites:

PCB Design (Workshop-1), Engineering Drawing, Project-based Learning (PBL)

Course Objectives:

This course introduces the students to the basic concepts of engineering design and product development, focusing on the front-end and back-end processes. At the end of this course, the student is expected to demonstrate an understanding of all product development processes and knowledge of concept generation and tool selection.

Course Outcomes:

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

- CO 1. Analyze the approach to product design, functionalities, and customer needs.
- CO 2. Design products with a human interface using UX/UI design concepts.
- CO 3. Justify creativity and material selections for innovative product designs.
- CO 4. Analyze the need for market surveys and research.
- CO 5. Apply the concepts of creative design and innovation.

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Module No.	Unit No.	Details	Hrs.	CO
1		Introduction to Product Development	10	CO1
	1.1	Need for product development and new product development concepts.		
	1.2	Defining product functionality for customer needs, and life cycle (hardware and software).		
2		Quality Concept of Product Development	08	CO2
	2.1	Design criteria for quality in products, testing, failure modes, and effect analysis.		
	2.2	Design of experiments in product design, UI and UX specifications, national and international standards, and tools.		
3		Industrial Design and Integrated Product Design	10	CO3
	3.1	Industrial product and human interface, workspace considerations, and environmental design factors.		
	3.2	Cognitive ergonomics and human factor application, design, and role of aesthetics in product design, product manufacturing, testability, and scalability.		
4		Marketing Research and New Product Design	10	CO4
	4.1	Introducing marketing research, exploratory research design.		
	4.2	Innovation in product design by market research analysis, modern tools, and design (SolidWorks, Fusion 360, TinkerCAD, AutoCAD, 3D printing).		
5		Creativity in Design and Materials for Product Design	07	CO5
	5.1	Need for creative design and thinking, mechanisms of creative design and thinking, visualization.		
	5.2	Innovative material selection and its behavioral analysis, understanding of product modeling, and product assembly in product design. Introduction to the industry, challenges, and future trends.		
Total			45	—

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1.	Yousef Haik, T. M. M. Shahin	<i>Engineering Design Process</i>	Cengage, India	2 nd Edition Reprint, 2010
2.	Clive L. Dym, Patrick Little	<i>Engineering Design: A Project-based Introduction</i>	John Wiley & Sons, USA	3 rd Edition, 2009
3.	Montgomery, D.C.	<i>Design and Analysis of Experiments</i>	John Wiley & Sons, USA	10 th Edition, 2003
4.	Phillip J. Rose	<i>Taguchi Techniques for Quality Engineering</i>	McGraw-Hill, India	2 nd Edition, 2002

Course Code	Course Title							
	Integrated Circuit 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	50	–	–	–	–	100

Course prerequisites:

Analog Electronic Circuits, Basics of VLSI Design

Course Objectives:

Integrated Circuit fabrication is a very complex and challenging process which is actually a combination of multiple processes. Every process is dependent on the previous process. Curiosity in the minds of students should be triggered about this IC fabrication process and at least few students should get a chance to make their career in the VLSI.

Course Outcomes:

At the end of successful completion of the course the students will be able to:

- CO 1. Understand complexity and accuracy required in IC fabrication process.
- CO 2. Explain growth and deposition process in IC fabrication.
- CO 3. Explain patterning process in IC fabrication.
- CO 4. Implement Custom layout design techniques.
- CO 5. Describe usefulness of novel devices like SOI, GaSFET.

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Module No.	Unit No.	Details	Hrs.	CO
1		Environment and Crystal Growth for VLSI Technology 1.1 Environment: Semiconductor technology trend, Clean rooms, Wafer cleaning 1.2 Semiconductor Substrate: Crystal structure, Crystal defects, Czochralski growth, Bridgman growth of GaAs, Float Zone growth, Wafer Preparation and specifications.	06	CO1
2		Fabrication Processes Part 1 2.1 Deposition: Evaporation, Sputtering and Chemical Vapor Deposition. 2.2 Epitaxy: Molecular Beam Epitaxy, Vapor Phase Epitaxy, Liquid Phase Epitaxy, Evaluation of epitaxial layers. 2.3 Silicon Oxidation: Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality. 2.4 Diffusion: Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, impurity behavior, diffusion systems, problems in diffusion, evaluation of diffused layers. 2.5 Ion Implantation: Penetration range, ion implantation systems, process considerations, implantation damage and annealing.	15	CO2
3		Fabrication Processes Part 2 3.1 Etching: Wet chemical etching, dry physical etching, dry chemical etching, reactive ion etching, ion beam techniques. 3.2 Lithography: Photoreactive materials, Pattern generation and mask making, pattern transfer, Electron beam, Ion beam and X-ray lithography. 3.3 Device Isolation: Junction and oxide isolation, LOCOS, trench isolation.	09	CO3
4		Device Process Flow and Layout Design 4.1 CMOS Process Flow: N well, P-well and Twin tub. 4.2 Design rules, Layout of MOS based circuits (gates and combinational logic).	06	CO4

5	SOI, GaAs, and Novel Devices			09	CO5		
	5.1 SOI Technology: SOI fabrication using SIMOX, Bonded SOI and Smart Cut, PD SOI and FDSOI Device structure and their features, BJT Fabrication						
	5.2 GaAs Technologies: MESFET, Optoelectronic Devices (Photo Diode, LED)						
	5.3 Novel Devices: Silicon nanowire, CNTFET, Double gate MOSFET, Fin-FET						
Total Hours		45					

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition and Year of Publication
1.	Sorab K Ghandhi	<i>VLSI Fabrication Principles- Silicon and Gallium Arsenide</i>	Wiley, India	5 th Edition, 2023
2.	Gary S May, Simon M Sze	<i>Fundamentals of Semiconductor Fabrication</i>	Wiley, India	2 nd Edition, 2004
3.	James D Plummer, Michael D Deal, Peter B Griffin	<i>Silicon VLSI Technology</i>	Pearson, India	1 st Edition, 2009
4.	Stephen A Campbell	<i>The Science and Engineering of Microelectronic Fabrication</i>	Oxford University Press	2 nd Edition, 2001
5.	S. M. Sze	<i>VLSI Technology</i>	Tata McGraw-Hill Education, India	2 nd Edition, 2003
6.	Neil Weste, David Harris	<i>CMOS VLSI Design: A Circuits and Systems Perspective</i>	Pearson, India	4 th Edition, 2010

Course Code	Course Title							
	Multi-rate and Wavelet Transform							
	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	50	—	—	—	—	100

Course prerequisites:

Digital Signal Processing

Course Objectives:

The course is designed to provide students with a broad perspective in the field of Multirate signal processing. The course will cover basic operations like interpolation and decimation, and the basics of digital filter banks in multirate signal processing domain. The course also aims to cover STFT, CWT, DWT, Biorthogonal wavelets, and their respective applications.

Course Outcomes:

At the end of successful completion of the course, students will be able to:

1. Understand the fundamentals of Multirate signal processing.
2. Analyze various filter banks used in Multirate signal processing.
3. Understand continuous wavelet transform.
4. Understand discrete wavelet transform.
5. Apply wavelet transforms in various applications.

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Mod. No.	Unit No.	Details	Hrs.	CO
1		Fundamentals of Multirate Signal Processing	12	CO1
	1.1	Fundamentals of Multirate Systems. Basic building blocks – Up sampling, down sampling, aliasing. Mathematical framework for sampling rate change		
	1.2	Sampling rate conversion, Interconnection of Multirate DSP blocks, Multiplexer and Demultiplexer Functionality, Polyphase decomposition, Noble Identities, QMF bank		
2		Filter banks	10	CO2
	2.1	DFT-based Filter banks, Interpolated FIR filter design, Filter bank interpretation of Spectral analysis using DFT		
	2.2	Two channel maximally decimated filter bank, Signal impairments - Aliasing, Magnitude distortion, Phase distortion, Aliasing cancellation		
3		Continuous Wavelet Transform	08	CO3
	3.1	STFT, Properties of STFT, limitations and Applications		
	3.2	Definition of CWT, CWT as a correlation		
4		Discrete Wavelet Transform	10	CO4
	4.1	Need for DWT, Approximations of vectors in nested linear vector spaces, Example of Multi Resolution Analysis(MRA), Formal definition of MRA		
	4.2	Construction of general orthonormal MRA, Scaling function and subspaces, Implication of dilation equation and orthogonality, wavelet basis for MRA, decomposition and reconstruction filters		
5		Applications of Multirate Signal Processing	05	CO5
	5.1	Applications in image processing, narrowband Nyquist filters, signal denoising, biomedical engineering		
Total			45	–

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1	Raguhuver M. Rao & Ajit S. Bopadikar	Wavelet Transforms - Introduction to Theory Applications	PHI Publication	1st Edition, 1998
2	K.P Soman, K.I Ramchandran, N.G. Reshma	Insight into Wavelets from Theory to Practice	PHI Publication	3rd Edition, 2010
3	Stephane Mallat	A Wavelet Tour of Signal Processing	Academic Press	2nd Edition, 1999
4	G. Strang and T. Nguyen	Wavelets and Filter Banks	Wellesley Cambridge Press	1st Edition, 1996

Course Code	Course Title						
	Power Electronics and Drives						
	TH	P	TUT	Total			
Teaching Scheme (Hrs.)	03	—	—	03			
Credits Assigned	03	—	—	03			
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	50	—	—	—	100

Course prerequisites:

Power Electronics (116U40E611)

Course Objectives:

To make students aware about various applications of Power Electronics in Industry like UPS, SMPS, Induction heating, Battery Charger and controller design. To make students understand and analyze DC and AC drives.

Course Outcomes:

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

- CO 1. Understand and analyze the effect of source inductance in controlled rectifiers and develop mathematical models of basic Choppers in open loop and closed loop with feedback control.
- CO 2. Understand performance parameters and modulation methods of single and three-phase VSI and its applications in AC drives.
- CO 3. Analyze and compare various schemes of DC motor speed control including braking and types of DC drives for separately excited DC motor.
- CO 4. Analyze and compare various schemes of AC motor speed control.
- CO 5. Understand and appreciate the use of power electronics systems in industrial applications.

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Module No.	Unit No.	Details	Hrs.	CO
1		Rectifiers and Mathematical modeling for DC-DC Converters	13	CO1
	1.1	Effect of source inductance in 1-phase and 3-phase rectifiers, distortion in line current waveforms, voltage distortion for diode and SCR based rectifiers.		
	1.2	Average model, linearized and transfer function models, state-space average models of Buck, Boost, Buck-Boost converters. Feedback control of these converters (PI, and PID) and basics of controller design.		
	1.3	MATLAB/Simulink simulations for effect of source inductance on all types of controlled rectifiers.		
		Self Learning: - Study of dedicated ICs for rectifiers and DC to DC converters.		
2		DC to AC converters	06	CO2
	2.1	Performance parameters for Inverters. Harmonic reduction in output voltage for inverters.		
	2.2	Space Vector Modulation (SVM) technique for 3-phase VSI. Power generation, Saving power quality, Efficiency.		
		Self Learning: - Study of dedicated ICs for Inverters.		
3		Power Electronic Applications in DC Drives	13	CO3
	3.1	Various schemes of DC motor speed control, single-phase half-wave, semi converter & full converter drive for separately excited.		
	3.2	Shunt and series DC motor, Dynamic and Regenerative braking of DC motor.		
4		Power Electronic Applications in AC Drives	08	CO4
	4.1	Introduction to speed control of three-phase induction motor methods: i) Stator voltage ii) Variable frequency iii) Rotor resistance iv) V/f control.		
	4.2	Numerical on speed control methods.		
5		Power Electronic Applications	05	CO5
	5.1	Use of power electronic systems in SMPS, Battery charging systems, UPS, and Induction heating.		
Total			45	-

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1	Dr. P.S. Bimbhra	<i>Power Electronics</i>	Khanna Publications, India	4th Edition Reprint, 2008
2	M.D. Singh and K.B. Khanchandani	<i>Power Electronics</i>	Tata McGraw Hill Education, India	2nd Edition, 18th Reprint 2013
3	M. Rashid	<i>Power Electronics Circuits Devices and Applications</i>	Pearson Education	4th Edition, 2013
4	Ned Mohan	<i>Power Electronics: Converters, Applications and Design</i>	John Willey Publication	3rd Edition, 2002

Course Code	Course Title						
116U40E716	Robotics and 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
	ISE	IA	50	–	–	–	100

Course prerequisites:

Computer Science fundamentals, Linear algebra, Probability and statistics, Programming proficiency (e.g., Python, C/C++)

Course Objectives:

This course explores the fundamental principles and techniques of robotics and computer vision. Students will learn to design, program, and control robots and develop computer vision applications. The course includes hands-on labs, projects, and a focus on both theoretical understanding and practical implementation.

Course Outcomes:

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

- CO 1. Explain the basics of robotics and computer vision.
- CO 2. Understand the concepts of robotics including kinematics, dynamics, and control.
- CO 3. Describe computer vision concepts like image processing, feature extraction, object detection, and motion tracking.
- CO 4. Learn camera calibration, 3D vision, and depth sensing.
- CO 5. Familiarize with ethical considerations in robotics and computer vision applications.

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Module No.	Unit No.	Details	Hrs.	CO
1		Introduction to Robotics and Computer Vision	10	CO1
	1.1	Introduction to Robotics, types, Robot components, architecture, and applications. Introduction to Computer Vision, principles, and applications.		
	1.2	Sensors in Robotics and Computer Vision, Basic Image Processing in OpenCV.		
	1.3	Robotics and Computer Vision Integration - Combining Robotics and Computer Vision, Sensor integration in robots, Visual servoing, Simultaneous Localization and Mapping (SLAM).		
		Self-Learning: - Line Following Robot with Computer Vision, Object Tracking with a Robot.		
2		Robot Control and Kinematics	10	CO2
	2.1	Robot Control and Programming, Forward Kinematics.		
	2.2	Basic Robot Control, Inverse Kinematics, Differential kinematics, Workspace analysis.		
3		Computer Vision	10	CO3
	3.1	Image Processing and Filtering: Image Filtering Techniques, Image Enhancement, Edge Detection, and Feature Extraction.		
	3.2	Object Detection and Recognition: Object Detection Techniques, Image Segmentation, Object Recognition and Classification using pre-trained Models, Motion tracking.		
4		Camera Calibration and 3D Vision	08	CO4
	4.1	Camera models, Calibration, Stereo Vision, and 3D Reconstruction.		
	4.2	3D Vision and Depth Sensing.		
5		Robotics & Computer Vision Applications	07	CO5
	5.1	Gesture Recognition, Drone Technology, Autonomous Vehicles, Retail Automation, Augmented Reality (AR) and Virtual Reality (VR), Underwater Robots, Elderly Care Robots, Medical Robots, Defense Robots, Mobile Robots, Humanoid Robots.		
	5.2	Ethical considerations in robotics and computer vision.		
Total			45	—

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1	Robert Shilling	<i>Fundamentals of Robotics - Analysis and Control</i>	Prentice Hall of India	1st Edition, 2009
2	Peter Corke	<i>Robotics, Vision, and Control: Fundamental Algorithms in MATLAB</i>	Springer	1st Edition, 2011
3	Richard Szeliski	<i>Computer Vision: Algorithms and Applications</i>	Springer	2nd Edition, 2010
4	D. Forsyth and J. Ponce	<i>Computer Vision - A Modern Approach</i>	Prentice Hall	2nd Edition, 2015
5	E. R. Davies	<i>Computer Vision: Models, Learning, and Inference</i>	Cambridge University Press	1st Edition, 2009

Course Code	Course Title				
	Advanced Databases and Data Warehousing				
	TH	P	TUT	Total	
Teaching Scheme (Hrs.)	03	–	–	03	
Credits Assigned	03	–	–	03	
Examination Scheme	Marks				
	CA		ESE	TW	O
	ISE	IA	50	–	–
	30	20			100

Course prerequisites:

Basic knowledge of database management systems.

Course Objectives:

This course is designed to provide students with a deep understanding of advanced database concepts and data warehousing techniques. It covers both theoretical foundations and practical applications, enabling students to design, implement, and optimize complex database systems and data warehouses.

Course Outcomes:

After successful completion of the course, the student will be able to:

- CO 1. Design and implement complex database systems.
- CO 2. Optimize query performance.
- CO 3. Apply advanced SQL techniques.
- CO 4. Build and manage data warehouses.
- CO 5. Implement data security and access controls.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Advanced Database Concepts			CO1
	1.1	Database system architectures: centralized, client-server, server, parallel, distributed, network types.		
	1.2	Parallel databases: introduction, I/O parallelism, query parallelism, Design of parallel systems, parallelism on multicore processors.		
	1.3	Distributed databases: types, distributed transactions, commit protocols, concurrency control, query processing Cloud-based databases, directory systems.		
2	Object-based, Active, temporal, spatial, multimedia, and deductive databases			CO2
	2.1	Object-based Databases – overview, complex data types, inheritance, object identity, reference types, object-oriented versus object-relational, implementation.		
	2.2	Active, temporal, spatial, multimedia, and deductive database concepts.		
3	NoSQL databases and Big data storage systems			CO3
	3.1	Introduction to NoSQL systems, CAP theorem, NoSQL systems - document and MongoDB.		
	3.2	Key-Value, Column-Family, and Graph Databases. Use cases and applications of NoSQL Databases.		
4	Data Warehousing and analytics tools			CO4
	4.1	Introduction to data warehousing, data warehousing architecture and components.		
	4.2	Principles of Dimensional Modeling: ER Modeling vs. Dimensional Modeling, STAR schema, snowflake schema, Factless Fact Table, Schema Key.		
	4.3	ETL Overview: ETL Requirements and Steps, Data Extraction Techniques, Data Transformation and Data Loading.		
5	Advanced- SQL and OLAP (Online Analytical Processing) Concepts			CO5
	5.1	Advanced SQL and OLAP Concepts: Demand for Online Analytical Processing, major features, OLAP models, OLAP implementation considerations.		

Total	45	—
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Self-Learning: Study of any one OLAP Tool.

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1	Elmasri and Navathe	<i>Fundamentals of Database Systems</i>	Pearson Education, India	7th Edition, 2019
2	Paulraj Pon-niah	<i>Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals</i>	Wiley India	2nd Edition, 2017
3	Raghu Ramakrishnan and Johannes Gehrke	<i>Database Management Systems</i>	McGraw Hill, India	3rd Edition, 2018
4	Korth, Silber-chatz, Sudar-shan	<i>Database System Concepts</i>	McGraw Hill, India	6th Edition, 2019
5	Reema Thareja	<i>Data Warehousing</i>	Oxford	1st Edition, 2009

Course Code	Course Title							
	Cloud Computing Architecture							
	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	50	—	—	—	—	100

Course prerequisites:

Basics of Networking.

Course Objectives:

Cloud computing is a scalable services consumption and delivery platform that provides on-demand computing service for a shared pool of resources, namely servers, storage, networking, software, databases, applications, etc., over the Internet. The objective of the course is to introduce various aspects of cloud computing, including fundamentals, management issues, security challenges, and future research trends.

Course Outcomes:

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

- CO 1. Understand the fundamentals of Cloud computing.
- CO 2. Describe cloud computing architectures.
- CO 3. Illustrate virtualization in cloud computing.
- CO 4. Describe cloud security and solutions.
- CO 5. Learn the significance of cloud solutions through consumer case studies and future trends in cloud computing.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Cloud Computing		08	CO1
	1.1	Cloud Computing Definition, Need of cloud computing, Limitations of cloud computing, properties and characteristics of cloud computing.		
	1.2	Benefits of cloud computing for Market and Enterprises, for End user and Individuals, Different cloud providers and Comparison of services, infrastructure and platform service providers: Amazon (EC2), Google, Microsoft, Salesforce.		
2	Cloud Computing Architecture		10	CO2
	2.1	Service models of Cloud Computing(SaaS, PaaS, IaaS): System architecture, Component stack and scope of control, Cloud deployment models: public, private and hybrid cloud, comparison, Containerized services in cloud computing, Kubernetes		
	2.2	Architectural design of compute and storage clouds: security-aware cloud architecture, layered cloud architectural development, virtualization support and disaster recovery, architectural design challenges.		
3	Virtualization Technology		10	CO3
	3.1	Introduction, types of Virtualization: CPU Virtualization, memory Virtualization, device and I/O virtualization, network Virtualization, server Virtualization, client (desktop) and application advantages, virtualization at server/Compute, advantages.		
	3.2	Virtual machine and hardware components, Hypervisor taxonomy, types of hypervisor.		
4	Cloud Security and solutions		08	CO4
	4.1	Cloud security fundamentals, cloud risk, cloud risk division, cloud computing security architectures, VM security challenges.		
	4.2	Cloud information security objectives, Secure cloud software testing. Practical Cloud Defender (PCD), Data Center Disaster Recovery Architecture (DCDR), Service Discovery, and Security Containerization.		

	4.3	Introduction to Vulnerability Assessment for cloud. Self-study: Vulnerability Assessment tools for cloud, Netskope, cipher cloud, Skyhigh Networks, Okta, Qualys, Vaultive.		
		Self-study: Vulnerability Assessment tools for cloud, Netskope, CipherCloud, Skyhigh Networks, Okta, Qualys, Vaultive.		
5	Cloud computing consumer case studies		09	CO5
	5.1	Cloud infrastructure adaption case study, Cloud platform adaption case study, cloud software services adaption case study, Cloud simulation tools.		
	5.2	Future of Cloud Computing, Edge computing, Fog Computing, concept of mobile cloud computing.		
Total			45	-

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1	Antony T.Velte, Toby J.Velte, Robert Elsen-peter	<i>Cloud Computing: A Practical Approach</i>	McGraw Hill Professional, India	2009
2	Rishabh Sharma	<i>Cloud Computing Fundamentals, Industry Approach and Trends</i>	Wiley, India	1st Edition, 2015
3	Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra	<i>Distributed and Cloud Computing: From Parallel Processing to the Internet of Things</i>	Elsevier India Private Limited	1st Edition, 2012
4	Shailendra Singh	<i>Cloud Computing</i>	Oxford University Press	1st Edition, 2018
5	V.K. Pachghare	<i>Cloud Computing</i>	PHI India Learning	2016

Course Code	Course Title				
116U40E723	C# Programming and .NET Technology				
	TH	P	TUT	Total	
Teaching Scheme (Hrs.)	03	0	0	03	
Credits Assigned	03	0	0	03	
Examination Scheme		Marks			
		CA	ESE	TW	O
		ISE	IA		P
		30	20	50	—
					100

Course prerequisites:

Fundamentals of Object Oriented Programming concepts.

Course Objectives:

Creating Form-based applications using WPF and .NET controls. Creating ASP.NET applications using standard .NET controls. Connecting to data sources and managing them. Understanding the fundamentals of developing modular applications by using object-oriented methodologies.

Course Outcomes:

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

- CO 1. Understand .NET framework & fundamentals.
- CO 2. Utilize the .NET framework to build distributed enterprise applications.
- CO 3. Implement ADO.NET and LINQ concepts along with ASP.NET.
- CO 4. Develop web applications using a combination of client-side (JavaScript, HTML, XML, WML) and server-side technologies (ASP.NET, ADO.NET).
- CO 5. Develop ASP.NET Web Services, secure web services, and .NET remoting applications.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to .NET technologies		05	CO1
	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.		
	1.2	Concept of Master pages, Intrinsic Objects of ASP.NET, Structure of ASP.NET page, Cascading Style Sheet: Embedded, Inline, External.		
2	ASP.Net Core		10	CO2
	2.1	Introduction, What is ASP.NET Core, ASP.NET Core Features, Advantages of ASP.NET Core. ASP.NET Core Environment Setup, ASP.NET Core First Application Project Layout. Understanding Life Cycle of ASP.NET Core Request.		
	2.2	Controllers Overview, Action Methods and IActionResult, object Passing data from Controller to View, Understanding Action Selectors, Action Filters, Building Custom Action Filters, Introducing Razor View, Advantages of Razor View, Razor Syntax, Types of Views, Partial Views, Layout Pages, Special Views.		
3	ASP.NET MVC and Entity Framework Core		12	CO2
	3.1	Basic CRUD Operations using Entity Framework, Separation of work using BO Classes, Writing Generic Class / Repository, Caching in Repository, Cache Tag Helpers, Memory Caching, Introduction to In-Memory Caching, Response Cache, Distributed Cache.		
	3.2	URL Routing Overview, Custom Routes, Attribute Routing, Routing Constraint, Module Development by Understanding Areas, Adding Areas, Defining Area Routes, Linking between Areas.		
4	Overview of ADO.NET and XML		10	CO3
	4.1	ADO.NET Fundamentals: Understanding Databases, Configuring Your Database, Understanding SQL Basics, Understanding the Data Provider Model, Using Direct Data Access, Using Disconnected Data Access.		

	4.2	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.		
	4.3	LINQ Architecture, LINQ to Object, LINQ to SQL, LINQ to Dataset.		
5	Web services		08	CO4
	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.		
	5.2	Self Learning: Deployment of ASP.NET application.		
Total				45

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of publication
1	James Chambers, David Paquette, Simon Timms	<i>ASP.NET Core Application Development: Building an application in four sprints (Developer Reference)</i>	Microsoft Press	1st Edition, 2017
2	Rishabh Verma, Neha Shrivastava, Ravindra Akella	<i>Parallel Programming with C# & .NET Core</i>	BPB Publications	2020
3	Andrew Lock	<i>ASP.NET Core in Action</i>	Microsoft Press	2023
4	Steven Metsker	<i>Design Patterns in C# (The Software Patterns Series)</i>	Addison-Wesley Professional	1st Edition, 2004
5	Adam Freeman	<i>Pro ASP.NET Core MVC 2</i>	Apress	7th Edition, 2017

Course Code	Course Title					
116U40E724	Foundation of Machine Learning and Pattern Recognition					
	TH	P	TUT	Total		
Teaching Scheme (Hrs.)	3	0	0	3		
Credits Assigned	3	0	0	3		
Examination Scheme	Marks					
	CA		ESE	TW	O	
	ISE	IA	50	—	—	
	30	20				100

Course Prerequisites:

Programming Concepts.

Course Objectives:

This course introduces the fundamental concepts and techniques in machine learning and pattern recognition. Students will gain an understanding of the foundational principles behind machine learning algorithms and their application in pattern recognition tasks.

Course Outcomes:

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

- CO 1. Apply polynomial curve fitting techniques to model complex data.
- CO 2. Understand and implement linear models for regression.
- CO 3. Develop a strong foundation in linear models for classification.
- CO 4. Understand basic aspects of Neural Networks, Kernels and Sampling methods.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction & Probability Distributions		09	CO1
	1.1	Polynomial Curve Fitting, Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory.		
	1.2	Probability Distributions: Binary Variables, Multinomial Variables, The Gaussian Distribution, The Exponential Family, Nonparametric Methods.		
2	Linear Models for Regression		09	CO2
	2.1	Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison.		
	2.2	The Evidence Approximation, Limitations of Fixed Basis Functions.		
3	Linear Models for Classification		09	CO3
	3.1	Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models.		
	3.2	The Laplace Approximation, Bayesian Logistic Regression.		
4	Neural Networks		08	CO3
	4.1	Feed-forward Network Functions, Network Training, Error Backpropagation.		
	4.2	The Hessian Matrix, Regularization in Neural Networks, Mixture Density Networks, Bayesian Neural Networks.		
5	Kernel & Sampling Methods		10	CO4
	5.1	Dual Representations, Constructing Kernels, Radial Basis Function Networks, Gaussian Processes.		
	5.2	Basic Sampling Algorithms, Markov Chain Monte Carlo, Gibbs Sampling, Slice Sampling, Hybrid Monte Carlo Algorithm, Estimating the Partition Function.		
Total			45	—

Recommended Books:

S.No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1	Christopher M. Bishop	<i>Pattern Recognition and Machine Learning</i>	Springer	2020, 1st ed. 2006 edition
2	Andreas C. Müller & Sarah Guido	<i>Introduction to Machine Learning with Python: A Guide for Data Scientists</i>	O'REILLY	2016
3	Ian Goodfellow, Yoshua Bengio, and Aaron Courville	<i>Deep Learning</i>	The MIT Press	2016

Course Code	Course Title							
	Information and Cyber 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	50	—	—	—	—	100

Course Prerequisites:

Basics of Operating Systems, computer networks.

Course Objectives:

This course aims to introduce students to the basics of information security. It will also provide knowledge on malicious and non-malicious program errors and apply countermeasures. This course will help students to understand the importance of cyber security awareness necessary to be imbibed in every individual who is part of our society. This trains students to be a vigilant and secured citizen of the cyber world.

Course Outcomes:

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

- CO 1. Explain various security goals, threats, vulnerabilities and controls with various cryptographic algorithms for software security.
- CO 2. Discuss software flaws, malware and detection techniques.
- CO 3. Comprehend concept of cyber-crime, threats, security, cyber offenses and methods used in cybercrime.
- CO 4. Understand effective countermeasures to mitigate risk of cyber threats and crime.
- CO 5. Study and analyze Cyber Laws.

Module No.	Unit No.	Details	Hrs.	CO
1	Introduction		07	CO1
	1.1	What Is Computer Security?, Threats, Harm, Vulnerabilities, Controls.		
	1.2	Use of Cryptography in System Security: Problems Addressed by Encryption, Terminology, DES: The Data Encryption Standard, Public Key Cryptography, Public Key Cryptography to Exchange session key, Trust, Certificates: Trustable Identities and Public Keys, Digital Signatures.		
2	Software Security		09	CO2
	2.1	Software Flaws: Buffer overflow, Incomplete mediation, Race condition, Malware: and malware detection Botnets, Viruses, Trojan Horses, and Worms, Malicious Code.		
	2.2	Countermeasures: Countermeasures for Users, Countermeasures for Developers, Countermeasure Specifically for Security, Countermeasures that Don't Work.		
3	Understanding Cyber Crime and Cyber Offenses		10	CO3
	3.1	Classification of Cyber Crime, Categories of Cyber-crime.		
	3.2	Cyber Attack Lifecycle, Financial Frauds over Internet, Cyber Terrorism.		
	3.3	Methods: Phishing Attack and Identity Theft – Methods.		
	3.4	Techniques: Steganography, DoS and DDoS attacks, Password Cracking, Keyloggers, Spywares.		
	3.5	Attacks on Mobile Phones – Mobile Phone Theft, Mobile Viruses, Mishing, Vishing, Smishing, Hacking Bluetooth.		
	3.6	Attacks on Wi-Fi Network- Traditional Techniques, Theft of Internet Hours, Wi-Fi Misuses.		
4	Preventions and countermeasures to Cyber Attack		09	CO4
	4.1	Six Pillars of Cyber Security.		
	4.2	Preventive measures for Phishing and Identity Theft.		
	4.3	Preventive and Countermeasures for DoS and DDoS attacks.		

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	4.4	Best practices for Secure password, mobile phone and Wi-Fi Networks.			
	4.5	Organization Guidelines for Internet usage.			
	4.6	Safe computing, Best Practices for Netizens.			
5	Introduction to Cyber Laws		10	CO5	
	5.1	The Indian IT Act 2000 and its amendments, Weak Areas of Indian IT Act.			
	5.2	Intellectual Property in cyberspace, digital signature and the Indian IT Act.			
	5.3	PPP (Public Private Partnerships for cyber Security), GDPR Fundamentals.			
Total				45	
				—	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Mark Stamp	<i>Information Security Principles and Practice</i>	Wiley- India	Second Edition, 2018
2	Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies	<i>Security in Computing</i>	Prentice Hall	Eleventh, 2023
3	Nina Godbole, Sunit Belapure	<i>Cyber Security - Understanding Cyber Crimes, Computer Forensics and Legal Perspectives</i>	Wiley- India	2011
4	Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar	<i>Cyber Security and Cyber Laws</i>	Cengage	2018
5	James Graham, Richard Howard, Ryan Olson	<i>Cyber Security Essentials</i>	CRC Press	2018 Reprint
6	Maria Helen Maras	<i>Computer Forensics Cybercriminal, Laws And Evidence</i>	Jones & Bartlett Learning	2011

Course Code	Course Title						
	Software Testing & Quality Assurance						
	TH	P	TUT	Total			
Teaching Scheme (Hrs.)	03	–	–	03			
Credits Assigned	03	–	–	03			
Examination Scheme	Marks						
	CA		ESE	TW	O		
	ISE	IA	50	–	–		
	30	20			–	–	100

Course Prerequisites:

Software Engineering, Programming Concepts & Algorithms.

Course Objectives:

The objective of this course introduces fundamental principles and practices of software testing and quality analysis. It covers various testing techniques, methodologies, tools, and strategies to ensure the delivery of high-quality software products.

Course Outcomes:

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

- CO 1. Explore the fundamentals of testing.
- CO 2. Describe the various levels of testing.
- CO 3. Analyze various test cases for real-life applications.
- CO 4. Understand software quality concepts.
- CO 5. Identify software quality assurance goals and standards.

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Module No.	Unit No.	Details	Hrs.	CO
1	Fundamentals of Testing		09	CO1
	1.1	Introduction to software testing, Importance of software testing, The testing process and lifecycle, Role of a tester in the software development cycle, Failure, Error, Fault, and Defect, Objectives of Testing, What Is a Test Case, Expected Outcome, Concept of Complete Testing, Central Issue in Testing.		
	1.2	Testing Types: Unit testing, integration testing, system testing, and acceptance testing, Functional, non-functional, and structural testing, Black-box vs. white-box testing.		
2	Levels of Testing		09	CO2
	2.1	The Need for Levels of Testing, Unit Test, Unit Test Planning, Designing the Unit Tests, The Class as a Testable Unit, The Test Harness, Running the Unit tests and Recording results, Integration tests, Designing Integration Tests, Integration Test Planning, System Test – The Different Types, Regression Testing, Alpha, Beta and Acceptance Tests.		
3	Test Case Design and Implementation:		09	CO3
	3.1	Introduction to Testing Design Strategies, Test Case Design Strategies, Using Black Box Approach to Test Case Design, Random Testing, Equivalence Class Partitioning, Boundary Value Analysis, Using White-Box Approach to Test design, Coverage and Control Flow Graphs, Covering Code Logic, Additional White Box Test Design.		
4	Fundamentals of Quality Assurance		09	CO4
	4.1	Introduction, The Software Quality Challenge, Software Quality Factors. The Components of the Software Quality Assurance System - Overview.		
	4.2	Pre-Project Software Quality Components, Contract Review, Development and Quality Plans.		

	4.3	SQA Components in the Project Life Cycle, Integrating Quality Activities in the Project Life Cycle, Reviews, Software Testing – Strategies, Implementation, Assuring the Quality of Software Maintenance, Vulnerability assessment and penetration testing (VAPT), Cybersecurity norms in software testing, Assuring the Quality of External Participants, Parts, Case Tools and their Effect on Software Quality.		
5	Software Quality Assurance		09	CO5
	5.1	Software Quality Infrastructure Components, Procedures and Work Instructions, Supporting Quality Devices, Staff Training, Instructing and Certification, Preventive and Corrective Actions, Configuration Management, Documentation and Quality Records Controls.		
	5.2	Software Quality Management Components, Project Progress Control, Software Quality Metrics, Software Quality Costs.		
Total			45	–

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Kshirsagar Naik, Priyadarshi Tripathy	<i>Software Testing & Quality Assurance</i>	Wiley, India	1st Edition, 2016
2	Naresh Chauhan	<i>Software Testing Principles & Practices</i>	Oxford University Press	2nd Edition, 2016
3	Daniel Galin	<i>Software Quality Assurance: From Theory to Implementation</i>	Pearson Publishers	1e Paperback, 1 January 2008

Course Code	Course Title							
	Project - I%							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	00	08	00	08				
Credits Assigned	00	04	00	04				
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA	00	25*	25	-	-	50

*Based on periodic assessment of progress of project

% For Students opting for one semester internship for semester VIII, project I will not continue to Project II.

Course Outcomes:

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

- CO 1. Identify and formulate real world problem.
- CO 2. Design Electronic components and systems to meet specifications of identified problem.
- CO 3. Plan Timeline execution of entire project work.
- CO 4. Use hardware and software tools for efficient implementation of project work.

Term work:

The final year students have experienced project execution in their pre-final year in Mini Project. In the final year group of maximum three students will be completing a comprehensive project work based on the knowledge gained. The project work may be internally assigned or may be externally assigned by the research institutes, industry etc. Each group will be assigned one faculty as a supervisor. This project work in final year may be an extension of the Mini Project work done in pre-final year. The main intention of Project work is to enable students to apply the knowledge and skills learned to solve/implement predefined real-world problems. The Project work may be beyond the scope of curriculum but thrust should be-

1. Learning additional skills
2. Ability to define a problem, analyze, design and implement a solution with proper planning
3. Develop team spirit by working in a group
4. The project area may be selected in which the student intend to do further education and/or may be either intend to have employment or self-employment
5. The topic of project may be advancement in the same topic of Mini Project.
6. The students may use this opportunity to learn different computational techniques as well as some model development.

Students are expected to report to the faculty advisor about the progress of the work. A continuous assessment record of the progress of the project will be maintained by concerned faculty members. At the end of the semester a Report in prescribed format should be submitted by the students. The work of the students will be evaluated by approved internal faculty appointed by the head of the institute and it should be assessed for awarding TW marks. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student will be assessed for his/her contribution, understanding and knowledge gained.

Course Code	Course Title						
116U40L701	Artificial Intelligence and Machine Learning Laboratory						
	TH	P	TUT	Total			
Teaching Scheme (Hrs.)	—	02	—	02			
Credits Assigned	—	01	—	01			
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	—	25	25	—	—
							50

Term work will consist of experiments covering the entire syllabus of “Artificial Intelligence and Machine Learning” (116U40C701). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Study of AI projects and Turing Test
2. Study of Python Libraries and frameworks for machine learning
3. Implementation of Multiple Linear Regression on a given dataset and compute the performance measures of the model
4. Write a program to implement Logistic Regression using any appropriate dataset and compute the performance measures of the model
5. Implement Random forest ensemble method on a given dataset and compute the performance measures of the model
6. Apply k-Means algorithm to cluster a set of data stored in a .CSV file. Vary k , obtain the results and comment on the quality of clustering. Print both correct and wrong predictions.
7. Apply SVM algorithm to a dataset. Implement Dimensionality reduction using Principal Component Analysis (PCA) method. Compare the results and performance measures of both models.

8. Write a program to implement the Naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
9. Write a program to demonstrate the working of the decision tree-based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
10. Mini Project on applications of deep learning (CNN/RNN/GAN)

Course Code	Course Title							
	Embedded System Design Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—		02	—	02			
Credits Assigned	00		01	—	01			
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Embedded System Design” (116U40E711). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. LED Interface
2. LCD and Keyboard Interface
3. Counter Using Seven Segment Display
4. Real Time Clock
5. DC Motor Interface
6. Analog to Digital Converter
7. Task Creation using Free RTOS
8. Binary Semaphore implementation using Free RTOS

Course Code	Course Title							
	Industrial Product Design Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—		02	—	02			
Credits Assigned	00		01	—	01			
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Industrial Product Design” (116U40E712). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Idea Generation
2. Market Research and Survey
3. Brainstorming
4. Sketching practice
5. Drawing Final Product
6. Prototype Design
7. Final Presentation

Course Code	Course Title							
	Integrated Circuit Technology Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—	02	—	02				
Credits Assigned	—	01	—	01				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Integrated Circuit Technology” (116U40E713). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

List of Experiments:

1. Building a PN junction diode and simulating the V-I characteristics using TCAD. (**CO1**)
2. Building a NMOS device structure using TCAD and simulating the V-I characteristics and transfer characteristics of NMOS as inverter (**CO2**)
3. Building a PMOS device structure using TCAD and simulating the V-I characteristics and transfer characteristics of NMOS as inverter (**CO2**)
4. Study of oxidation process with Nanohub.org (**CO2**)
5. Study of diffusion process with Nanohub.org (**CO2**)
6. Implementation of NAND and NOR logic using CMOS technology with the help of lambda-based rules (**CO3**)
7. Implementation of Digital logic expression using CMOS technology with the help of lambda-based rules (**CO3**)
8. Comparison of CMOS Inverter, BiCMOS, and MESFET Inverter using LTSpice (**CO5**)
9. Building a SOI device using VTCA (**CO5**)
10. Building a Twin-tub CMOS using VTCAD (**CO3**)

Course Code	Course Title						
116U40L714	Multi-rate and Wavelet Transform Laboratory						
	TH		P	TUT	Total		
Teaching Scheme (Hrs.)	—		02	—	02		
Credits Assigned	00		01	—	01		
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	—	25	25	—	—
							50

Term work will consist of experiments covering the entire syllabus of “Multi-rate and Wavelet Transform” (116U40E714). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Write a MATLAB code to obtain Fourier transform of stationary and non-stationary signals
2. Write a MATLAB code to obtain STFT of stationary and non-stationary signals
3. Obtain Continuous Wavelet Transform of the given stationary and non-stationary signals
4. Write a MATLAB code to obtain DWT of stationary and non-stationary signals
5. Generate Haar scaling function by iterating a 2-band filter bank
6. Generate Daub-4 scaling function
7. Build a 2-band Haar filter bank and obtain output at each point for a given input signal/sequence
8. De-noising a corrupted signal using suitable wavelet transform
9. Perform decomposition on a given image using wavelet transform and reconstruct the image

Course Code	Course Title							
	Power Electronics and Drives Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	00	02	–	02				
Credits Assigned	00	01	–	01				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	–	–	–	25	25	–	–	50

Term work will consist of experiments covering the entire syllabus of “Power Electronics and Drives” (116U40E715). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Simulations for the effect of source inductance on various controlled rectifiers
2. To study the SCR series inverter. (Hardware Experiment)
3. To study the speed control of DC motor using dc chopper. (Hardware Experiment)
4. To study the principle and working of universal motor speed controller using SCR. (Hardware Experiment)
5. Speed control of Single Phase Separately excited DC Motor using full converter. (Simulation based experiment)
6. Speed control of Single Phase Separately excited DC Motor using semi converter. (Simulation based experiment)
7. AC DRIVE V/F control (Simulation based experiment)
8. AC DRIVE variable frequency control (Simulation experiment)

Course Code	Course Title							
	Robotics and Computer Vision Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—	02	—	02				
Credits Assigned	—	01	—	01				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Robotics and Computer Vision Laboratory” (116U40E716). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Obstacle Avoidance: Develop a program for a robot to navigate through a predefined path while avoiding obstacles using sensors.
2. Line Following Robot: Build a robot that can follow a line on the floor using line sensors or computer vision.
3. Pick and Place Robot: Create a robot to pick up objects and place them in a specific location, simulating an assembly line.
4. Inverse Kinematics: Study and implement inverse kinematics to control the end-effector of a robot arm to reach desired positions and orientations.
5. Robot Vision Calibration & Object Tracking: Calibrate a robot's camera's intrinsic and extrinsic parameters to ensure accurate measurements. Develop a system for tracking and following a moving object with a robot's camera or sensors.
6. Image Filtering & Edge Detection: Implement various image filtering techniques like Gaussian, median, and Sobel filters to enhance or extract features from images.
7. Object Recognition: Implement object recognition using methods like Haar cascades or deep learning-based approaches (e.g., CNNs).

8. Object Detection and Tracking: Combine object detection and tracking to follow objects in real-time video streams.
9. Depth Sensing: Use depth-sensing cameras or stereo-vision techniques to estimate the depth of objects in a scene.
10. Motion Tracking: Track the movement of objects or people in a video stream.
11. Mini Project: Develop a system (like facial recognition, motion tracking, gesture recognition, etc.) using OpenCV or other computer vision libraries.

Course Code	Course Title							
116U40L721	Advanced Databases and Data Warehousing Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—	02	—	02				
Credits Assigned	00	01	—	01				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA	—	25	25	P	P&O	Total
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Advanced Databases and Data Warehousing” (116U40E721). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Optimizing SQL Queries for Performance
2. Database Design and Normalization
3. Implementing ACID Transactions
4. NoSQL Database Comparison
5. Data Warehousing and ETL Processes
6. Concurrency Control and Deadlock Handling
7. Database Security and Access Control
8. Data Backup and Recovery Strategies
9. Distributed Database Management
10. Big Data and NoSQL Integration

Course Code	Course Title							
	Cloud Computing Architecture Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	0	2	–	2				
Credits Assigned	0	1	–	1				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA	00	25	25	P	P&O	Total
	00	00	00	–	–	–	–	50

Term work will consist of experiments covering the entire syllabus of “Cloud Computing Architecture” (116U40E722). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

List of Experiments:

1. Demonstration of DaaS (Desktop as a Service) service (**CO1**)
2. Implementation of Virtualization using VirtualBox and OS virtualization (**CO3**)
3. To host Webpages on Google Cloud Platform (GCP) Application: PaaS implementation (**CO2**)
4. To demonstrate Google app programming with Java (**CO2**)
5. To demonstrate Google app programming with Python (**CO2**)
6. To analyze Gas sensor data on Thingspeak cloud for SaaS implementation (**CO2**)
7. Demonstration of Amazon Web Services (**CO1, CO2**)
8. Create AWS gateway endpoint for s3 bucket (**CO4,CO5**)
9. Study experiment: Case study on any cloud-based application (**CO5**)

Course Code	Course Title						
	C# Programming and .NET Technology Laboratory		TH	P	TUT	Total	
Teaching Scheme (Hrs.)			00	02	–	02	
Credits Assigned			00	01	–	01	
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	00	25	25	–	–
			50				

Term work will consist of experiments covering the entire syllabus of “C# Programming and .NET Technology” (116U40E723). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Classes and Objects
2. Inheritance
3. Operator Overloading
4. Threading
5. Events and Delegates
6. Working with Windows Forms Controls
7. Validating Data
8. Creating Custom Dialog Box
9. Designing an MDI Application with Menu
10. Retrieving Data from a SQL Database
11. Manipulating Data in a Connected Environment
12. Manipulating Data in a Disconnected Environment

Course Code	Course Title						
116U40L724	Foundation of Machine Learning and Pattern Recognition Laboratory						
Teaching Scheme (Hrs.)	TH		P	TUT	Total		
Credits Assigned	00		01	—	01		
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	—	25	25	—	—
							50

Term work will consist of experiments covering the entire syllabus of “Foundation of Machine Learning and Pattern Recognition” (116U40E724). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Polynomial Curve Fitting Experiment: Implement polynomial curve fitting to model a dataset with varying degrees of polynomial functions. Evaluate the model's performance with different complexities and analyze overfitting and underfitting.
2. Probability Distributions Exploration: Experiment with different probability distributions (e.g., Gaussian, Multinomial, Exponential Family). Use these distributions to model real-world data and visualize the results.
3. Binary and Multinomial Classification: Implement a classifier using binary and multinomial variables. Train the model on a dataset and evaluate its performance, analyzing the influence of different distributions on the classification accuracy.
4. Linear Regression with Basis Functions: Apply linear regression using various basis functions (e.g., polynomial, Gaussian). Evaluate the model with bias-variance decomposition and explore the impact of different basis functions on model accuracy.

5. Bayesian Linear Regression: Develop a Bayesian linear regression model and compare its performance against a traditional linear regression model. Analyze posterior distributions and model uncertainty.
6. Model Selection and Regularization: Experiment with different model selection techniques and regularization methods (e.g., L1, L2 regularization) to prevent overfitting. Evaluate the models using cross-validation.
7. Discriminant Functions for Classification: Implement discriminant functions for classification, including probabilistic generative and discriminative models. Compare and evaluate their performance on a classification dataset.
8. Logistic Regression with Bayesian Inference: Perform Bayesian logistic regression, using Laplace approximation for posterior estimation. Analyze the effect of prior distributions on model performance.
9. Neural Network Implementation and Backpropagation: Build a basic feed-forward neural network and implement backpropagation for training. Experiment with different architectures and learning rates to study their effects on training accuracy.
10. Regularization in Neural Networks: Implement regularization techniques (e.g., dropout, L2 regularization) in a neural network and observe their impact on reducing overfitting and improving model generalization.
11. Kernel Methods for Nonlinear Classification: Implement a kernel-based model for classification (e.g., SVM with RBF kernel). Explore different kernel functions and analyze their impact on model performance.
12. Sampling Techniques for Bayesian Inference: Experiment with sampling techniques (e.g., MCMC, Gibbs Sampling) to estimate parameters in a Bayesian model. Apply these methods to a dataset and evaluate convergence and sampling efficiency.

Course Code	Course Title					
	Information and Cyber Security Laboratory					
	TH	P	TUT	Total		
Teaching Scheme (Hrs.)	—	02	—	02		
Credits Assigned	—	01	—	01		
Examination Scheme	Marks					
	CA		ESE	TW	O	P
	ISE	IA	—	25	25	P&O
	—	—	—	—	—	50

Term work will consist of experiments covering the entire syllabus of “Information and Cyber Security” (116E40E725). Students will be graded based on continuous assessment of their term work.

Oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Experiments on Encryption Decryption Algorithms
2. Hash Functions and Applications
3. Public-Key Cryptosystems
4. Study and Implementation of Various Types of Software Flaws
5. Vulnerability Scanners
6. Use of OpenSSL
7. Study of Cyber Attacks
8. Email Security
9. Packet Analyzers

Course Code	Course Title						
	Software Testing & Quality Assurance Laboratory		TH	P	TUT	Total	
Teaching Scheme (Hrs.)			—	02	—	02	
Credits Assigned			—	01	—	01	
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	—	25	25	—	—
							50

Term work will consist of experiments covering the entire syllabus of “Software Testing & Quality Assurance” (116U40E726). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

List of Experiments:

1. Study an open source software testing tool for manual testing.
2. Create a test plan document for any application.
3. Study any web testing tool, such as Selenium, for testing web applications.
4. Generate test cases using manual testing for simple applications.
5. Generate test cases using White box testing techniques like Data flow and Control flow analysis.
6. Measure software quality of Somaiya LMS using different quality factors.
7. Perform Black box testing approach for your final year project using a test automation tool.
8. Perform White box testing approach for your final year project using a test automation tool.

Course Code	Course Title							
116U40E811	Artificial Intelligence Based Wireless Network Design							
	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	50	—	—	—	—	100

Course Prerequisites:

Basic understanding of computer networking and wireless communication concepts, Fundamentals of machine learning and artificial intelligence.

Course Objectives:

This course explores the integration of artificial intelligence (AI) techniques in the design, optimization, and management of wireless networks. The course covers both theoretical concepts, real world case studies, and practical applications enabling students to develop AI-based solutions to enhance the efficiency, reliability, and security of wireless communication systems.

Course Outcomes:

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

- CO 1. Understand the fundamentals of wireless network design with AI.
- CO 2. Apply AI techniques to optimize network performance and develop AI-based solutions for wireless network security.
- CO 3. Apply AI techniques to manage wireless networks effectively.
- CO 4. Evaluate the impact of AI on wireless communication systems through latest applications and trends in the field.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to AI and Wireless Networks		09	CO1
	1.1	Overview of AI and machine learning, Basics of wireless communication systems, Importance of AI in wireless network design, Use cases and applications		
	1.2	Wireless Network Architecture: Wireless network components and protocols, Network topologies and architectures, Wireless standards (e.g., Wi-Fi, 5G), AI-driven changes in network architecture		
2	AI for Wireless Network Optimization and Security		09	CO2
	2.1	Optimization techniques in wireless networks: AI-based resource allocation, Quality of Service (QoS) optimization		
	2.2	Wireless network security challenges: AI-based intrusion detection, Threat identification and prevention, Secure network design with AI		
3	AI in Network Management		07	CO3
	3.1	Network monitoring and management: AI-driven predictive maintenance, Fault detection and recovery		
	3.2	Case studies on AI-enabled network management		
4	Industry Applications and Recent trends in AI and Wireless Networks		05	CO4
	4.1	Real-world applications of AI in wireless network design, Case studies		
	4.2	Research Trends and Future Directions, Emerging trends in AI and wireless networks, Research opportunities		
Total			30	—

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Hong-Chuan Yang and Sunghyun Choi	<i>Artificial Intelligence for Wireless Communications</i>	Springer	1st Edition, 2019
2	K. Suganthi, R. Karthik, G. Rajesh, and Peter Ho Chiung Ching	<i>Machine Learning and Deep Learning Techniques in Wireless and Mobile Networking Systems</i>	CRC Press, Taylor & Francis Group, Florida, US	1st Edition, 2022
3	Anuj Singhal, Sandeep Kumar, Sajjan Singh, Ashish Kr. Luhach	<i>Wireless Communication with Artificial Intelligence: Emerging Trends and Applications</i>	CRC Press, Taylor & Francis Group, Florida, US	1st Edition, 2023
4	Anil Kumar Sagar, Neetesh Kumar, Parma Nand, Sanjoy Das, Subrata Sahana	<i>Artificial Intelligence in Cyber Physical Systems: Principles and Applications (Wireless Communications and Networking Technologies)</i>	CRC Press, Taylor & Francis Group, Florida, US	1st Edition, 2023
5	Cory Beard and William Stallings	<i>Wireless Communication Networks and Systems</i>	Pearson	1st Edition, 2015

Course Code	Course Title							
	Deep Learning and Automation							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	02	0	0	02				
Credits Assigned	02	0	0	02				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA	50	—	—	P	P&O	Total
	30	20						100

Course Prerequisites:

Basic Mathematics, Python programming.

Course Objectives:

The objective of this course is to make students aware of new upcoming technologies of deep learning-based automation. This course combines the basics of deep learning and teaches students how to apply deep learning algorithms using Python programming. Upon completion of this course, the student will be able to identify the different electronic equipment used in automated systems. The students will acquire knowledge of how to use the most advanced deep learning technologies to automate various tasks that will help society.

Course Outcomes:

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

- CO 1. Understand the fundamentals of deep learning.
- CO 2. Understand basic concepts in deep convolutional neural networks.
- CO 3. Understand details of automation and the most advanced hardware.
- CO 4. Gain information on the usage of deep learning to build these systems.
- CO 5. Apply the acquired knowledge to test out various automation applications.

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Module No.	Unit No.	Details	Hrs.	CO
1	Basics of Deep Learning		06	CO1
	1.1	Introduction to deep learning, basics of learning algorithms		
	1.2	Hyperparameters of a Deep Learning Model and their optimization		
	1.3	Back-propagation algorithm, Error, Accuracy, Overfitting, Underfitting and capacity of network, Interpreting the accuracy and loss graphs		
2	Deep Learning with Convolutional Neural Networks		07	CO2
	2.1	Deep CNN model architecture, Working of CNN: Filters, filter size, stride length, padding, the convolution operation, Optimizers (Stochastic gradient descent, Adam, etc), Loss function, metrics, Callbacks, Regularization, Cross Validation		
	2.2	Deep Learning Frameworks: Definition and Purpose of Deep Learning Frameworks, Overview of popular Deep Learning Frameworks, Frameworks for Specialized tasks		
3	Introduction to Automation		06	CO3
	3.1	History of Automation, What can be automated, Types of automation, Effect of Automation on Production Volume and Cost		
	3.2	Examples of Automation and their Analysis: Quality Control, Electronic Circuit Assembly, Automobile Manufacturing, Robots, Software Automation		
	3.3	Hardware used in Automation: Actuators, Sensors, Data acquisition equipment and their purpose in a system		
4	Deep Learning with TensorFlow		07	CO4
	4.1	Installing TensorFlow and Keras, Importing necessary libraries using command prompt		
	4.2	Dataset creation, Data Augmentation, Binary and Multiclass classification, Class indices, Building a model, Using a Pre-trained model, Compile, Train, Evaluate, Prediction using trained model		

5	Automation with Deep Learning			04	CO5
	5.1	Deep learning applications: Multimedia classification, Speech classification, Text classification			
	5.2	Automation with Deep Learning: Quality Analysis in industries, Recommender Systems, Spam and Malicious detection, Medical Diagnosis Systems			
Total			30	—	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville	<i>Deep Learning</i>	MIT Press	1st Edition, 2016
2	Rajdeep Dua, Manpreet Singh Ghotra	<i>Keras Deep Learning Cookbook: Over 30 recipes for implementing deep neural networks in Python</i>	Packt Publishing Ltd	1st Edition, 2018
3	Ankit Jain	<i>TensorFlow Machine Learning Projects: Build 13 real-world projects with advanced numerical computations using the Python ecosystem</i>	Packt Publishing Ltd	1st Edition, 2018
4	Bharath Ramsundar, Reza Bosagh Zadeh	<i>TensorFlow for Deep Learning: From Linear Regression to Reinforcement Learning</i>	O'Reilly Media, Inc.	1st Edition, 2018
5	Frank Hutter	<i>Automated Machine Learning</i>	Springer	1st Edition, 2019

Course Code	Course Title							
	High Performance Computing							
	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	50	–	–	–	–	100

Course Prerequisites:

Programming in C, Data Structure, Digital Design, Computer organization and Architecture.

Course Objectives:

This course aims to equip students with a comprehensive understanding of parallel and distributed computing. It covers modern processor architectures, parallel programming models, and CUDA-based GPU programming. By the end of the course, students will be able to analyze, design, and implement parallel algorithms efficiently, addressing performance bottlenecks and handling the challenges of synchronization and resource management in parallel systems.

Course Outcomes:

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

- CO 1. Understand modern processor architectures, performance metrics, and benchmarks.
- CO 2. Explain various levels of parallelism and parallel computing models, including SIMD, MIMD, and SPMD.
- CO 3. Develop parallel programs using CUDA for GPU-based parallel processing.
- CO 4. Design and optimize parallel algorithms for tasks like scan, reduction, and convolution.
- CO 5. Discuss fundamental challenges and solutions in parallel computing, including synchronization, latency, and bandwidth limitations.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Computing		02	CO1
	1.1	Modern Processors. Performance metrics and benchmarks, Pipelining, Memory hierarchies, Improving performance on a single processor: basic optimization techniques for serial code. Data access optimization.		
2	Parallel Processing Concepts		06	CO2
	2.1	Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation, etc)		
	2.2	Architectures: N-wide superscalar architectures, multi-core, multi-threaded, Measuring performance, Parallel-serial problem breakdown, Basic Design of Parallel Algorithms. Amdahl's law, Complexity analysis. Dependence testing. Loop carried dependence, Granularity.		
3	Parallel Programming with GPU/CUDA & Programming model		12	CO3
	3.1	Setting Up CUDA, Compile and execute simple CUDA program structure, Profiling CPUs and GPUs. GPU NVIDIA architecture, Kernel functions and threading. Global memory and data transfer		
	3.2	Basic CUDA program structure, kernel calls, threads, blocks, grid, thread addressing, predefined variables		
	3.3	Vector addition kernel. Mapping threads to data. Assigning resources. Device query. Thread scheduling. Warps and thread execution. Control divergence. Matrix-Matrix multiplication – basic kernel.		
4	CUDA based Design and Parallelization of Important Parallel Algorithms		06	CO4
	4.1	Scan, Reduction, Convolution		
	4.2	Prefix-sum, Parallel Histogram, Sparse Matrix computation, Merge-sort		

5	Parallel Computing			04	CO5		
	5.1	Fundamental Design Issues in Parallel Computing: a) Synchronization b) Scheduling c) Job Allocation d) Job Partitioning e) Dependency Analysis f) Mapping Parallel Algorithms onto Parallel Architectures g) Per- formance Analysis of Parallel Algorithm					
	5.2	Fundamental Limitations Facing Parallel Computing: a) Bandwidth Limitations b) Latency Limitations c) Latency Hiding/Tolerating Techniques and their limi- tations					
Total				30	—		

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	David Kirk, Wenmei Hwu	<i>Programming Massively Parallel Processors: A Hands-on Approach</i>	Elsevier - Katey Birtcher, US	3rd Edition, 2017
2	Shane Cook	<i>CUDA Programming: A Developer's Guide to Parallel Computing with GPUs</i>	Elsevier Science - Morgan Kaufmann, US	2nd Edition, 2013
3	Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar	<i>Introduction to Parallel Computing</i>	Pearson, South Asia	2nd Edition, 2009
4	Jason Sanders and Edward Kandrot	<i>CUDA by Example: An Introduction to General-Purpose GPU Programming</i>	Addison-Wesley Professional (US)	3rd Edition, 2017

Course Code	Course Title					
	Speech Processing using Machine Learning					
	TH	P	TUT	Total		
Teaching Scheme (Hrs.)	03	0	0	03		
Credits Assigned	03	0	0	03		
Examination Scheme	Marks					
	CA		ESE	TW	O	
	ISE	IA	50	—	—	
	30	20			—	100

Course Prerequisites:

Python Programming, Networks, Signals and Systems, Digital Signal Processing.

Course Objectives:

To demonstrate basic knowledge in speech production mechanism, phoneme classification, digital models for speech production, Homomorphic speech processing, and LPC analysis. This course provides an introduction to the theory and practice of speech processing using machine learning techniques. Students will learn the fundamentals of speech signal analysis, feature extraction, demonstrate applications of signal processing theory for estimation of speech parameters in time and frequency domain including pitch and formants, and machine learning algorithms applied to various speech processing tasks.

Course Outcomes:

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

- CO 1. Understand theory and basic concepts of speech production.
- CO 2. Analyze speech signal in time and frequency domain.
- CO 3. Study various techniques used in speech processing.
- CO 4. Study various applications in speech processing.

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Module No.	Unit No.	Details	Hrs.	CO
1	Speech Production, Acoustic Phonetics, and Auditory Perception		08	CO1
	1.1	Overview of Speech Processing, Characteristics of Speech Signals, Speech Production and Perception, Anatomy and physiology of speech organs, articulatory phonetics, acoustic phonetics, review of DSP		
	1.2	Acoustic theory of speech production, discrete-time model for speech production, STFT, Mel-Frequency Cepstral Coefficients (MFCCs), Ear physiology		
2	Speech Analysis in Time Domain & Frequency Domain		11	CO2
	2.1	Time energy, average magnitude, and zero-crossing rate, speech vs. silence discrimination		
	2.2	Time-dependent Fourier representation for voiced and unvoiced speech signals, linear filtering interpretation, and spectrographic displays.		
	2.3	Pitch period estimation using short-time autocorrelation, Pitch period estimation based on FFT and harmonic peak detection method, estimation of formants using log spectrum		
3	Data Preprocessing and Optimization techniques		08	CO3
	3.1	Basic digital representation of speech data, Complex Exponential functions - Shannon Information Theory, Convolution, Correlation and Covariance Functions - Wavelets, Fourier Transform, DCT and Wavelets, Gaussian Processes		
	3.2	Dictionary based representations, Eigen representations, Karhunen Loeve Theorem, Principal Component Analysis, Independent Component Analysis (ICA) for representations and denoising, Non-negative matrix factorization		
4	ML for speech processing		10	CO3
	4.1	Introduction to classical approaches, Hidden Markov Models (HMMs) for ASR, Gaussian Mixture Model (GMM), GMM-UBM, GMM-i Vector		
	4.2	Deep Learning in ASR: Deep Neural Networks (DNNs), Sequence-to-Sequence Models, End-to-End Models		

	4.3	Introduction to Automatic Speech Recognition (ASR), Speaker Recognition System (SRS), Evaluation metrics for ASR & SRS		
5	Speech Processing Applications		08	CO4
	5.1	Speech enhancement, Speech coding, Emotion recognition, Voice morphing, Text-to-speech system (TTS) synthesis, Voice cloning and voice conversion, Sentiment analysis of Speech.		
	5.2	Recent Trends in Speech processing for healthcare applications, social and affective computing, industry and research		
Total			45	—

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Rabiner and Schafer	<i>Digital Processing of Speech Signals</i>	Pearson Education, Delhi	1st Edition, 2004
2	Shaila D. Apte	<i>Speech and Audio Processing</i>	Wiley India, New Delhi	1st Edition, 2012
3	Homayoon Beigi	<i>Fundamentals of Speaker Recognition</i>	Springer	1st Edition, 2011
4	Fouad Sabry	<i>Speaker Recognition: Fundamentals and Applications</i>	One Billion Knowledgeable	1st Edition, 2023
5	Ben Gold and Nelson Morgan	<i>Speech and Audio Signal Processing: Processing and Perception of Speech and Music</i>	Wiley India Pvt. Limited	1st Edition, 2006
6	Dong Yu and Li Deng	<i>Automatic Speech Recognition: A Deep Learning Approach</i>	Springer London (ebook)	1st Edition, 2014

Course Code	Course Title							
	Wireless Sensor Network & IoT							
	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	50	–	–	–	–	100

Course Prerequisites:

NIL

Course Objectives:

This course is an introduction to Wireless Sensor Network and Internet-of-Things. Students will understand the basic fundamental challenges and study state-of-the-art technologies, in terms of WSN and IoT system architecture along with its communication protocols. Students will learn case studies related to cloud-connected wireless Internet-of-Things smart systems.

Course Outcomes:

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

- CO 1. Understand the architecture, connectivity & area coverage of Wireless Sensor Networks.
- CO 2. Analyze data aggregation and routing techniques in WSN.
- CO 3. Describe fundamentals of IoT.
- CO 4. Comprehend various IoT enabling techniques like cloud computing, IoT communication protocols, and data analytics.
- CO 5. Apply concepts of WSN and IoT for domain-specific applications.

Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Wireless Sensor Network (WSN)		06	CO1
	1.1	Fundamentals of Internet, TCP/IP, Architecture of Protocol stack for WSN, WSN standards.		
	1.2	The Sensor Network Concept: Introduction, Deployment & Connectivity, Applications of wireless sensor networks, WSN Architectures, Flat and Hierarchical architecture, Energy consumption of sensor nodes.		
2	Data Aggregation in WSN		06	CO2
	2.1	Sensor Network Scenarios, Routing strategies and techniques in WSN, energy-efficient routing SPIN, LEACH and PEGASIS, Geographical routing.		
	2.2	Service interfaces of WSNs, Gateway Concepts, sensor network selection and Gateway concepts, General architecture of WSN for IoT.		
3	Introduction to Internet of Things (IoT)		05	CO3
	3.1	Characteristics of IoT, IoT Architecture, IoT Key terms: IoT Platform, Interfaces, API, clouds, Data Management Analytics, Mining & Manipulation, IoT Challenges and Security.		
	3.2	IoT Design methodology: Steps involved in IoT system design and methodology, Process specification, Domain model specification, Information model specification, Service level specification.		
4	IoT Enabling Technologies		08	CO4
	4.1	Recent trends in computing, Evolution of cloud computing, Advantages of Cloud computing, characteristics of cloud computing, Components of cloud computing, service models, Software as a service, Platform as a service, Infrastructure as a service, Deployment models: Public cloud, Private cloud, Hybrid cloud, Community cloud, Self-learning: distributed cloud, multi-cloud, Inter-cloud, Cloud edge computing.		
	4.2	Wireless Communication protocol: Wireless M-Bus, LWIP, WiFi, MQTT, LoRA, 6LoWPAN.		

	4.3	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.		
5	Domain Specific IoT Applications		05	CO5
	5.1	Home Automation, Smart Cities, Smart Grid		
	5.2	Environment, Agriculture, Health		
Total			30	—

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Arsheep Bahga, Vijay Madisetti	<i>Internet of Things: A Hands-On Approach</i>	Universities Press	1st Edition, 2015
2	Olivier Hersent, David Boswarthick, Omar Elloumi	<i>The Internet of Things Key Application and Protocol</i>	Wiley Student Edition, India	1st Edition, 2016
3	Holger Karl, Andreas Willig	<i>Protocols, and Architectures: For Wireless Sensor Networks</i>	Wiley Student Edition, India	1st Edition, 2016
4	Waltenegus Dargie and Christian Poellabauer	<i>Fundamentals of Wireless Sensor Networks-Theory & Practice</i>	John Wiley publication, USA	1st Edition, 2010
5	J. Zheng and A. Jamalipour	<i>Wireless Sensor Networks: A Networking Perspective</i>	John Wiley publication	1st Edition, 2009
6	Raj Kamal	<i>Internet of Things: Architecture and Design Principles</i>	McGraw Hill India	2nd Edition, June 2022

Course Code	Course Title					
116U40E816	Blockchain Technology					
	TH	P	TUT	Total		
Teaching Scheme (Hrs.)	02	–	–	02		
Credits Assigned	02	–	–	02		
Examination Scheme	Marks					
	CA		ESE	TW	O	P
	ISE	IA	50	–	–	–
	30	20				100

Course Prerequisites:

Data Structures, Networking Concepts, Object-Oriented Programming Skills, Cryptography and Digital Security Fundamentals.

Course Objectives:

The objective of this course is to understand the need and the fundamentals of blockchain and public/private/semi-private blockchain development platforms. The course provides details of Ethereum, Hyperledger, Corda, and Multichain platforms.

Course Outcomes:

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

- CO 1. Recall the basics of Blockchain Technology.
- CO 2. Understand the Ethereum Platform.
- CO 3. Understand the Hyperledger Platform.
- CO 4. Understand Corda and Multichain Platforms.

Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Blockchain Technology		07	CO1
	1.1	Distributed networks, Blocks and Blockchain, History of Blockchain, Motivation, and characteristics of Blockchain, distributed consensus - types and mechanisms/algorithms, consensus in blockchain, types of Blockchain.		
	1.2	Cryptographic background, ciphering, hashing, digital signatures, authentication, anonymity. The role of cryptography in blockchain.		
2	Ethereum Blockchain		07	CO2
	2.1	Introduction to Ethereum fundamentals and Features, Ethereum Blockchain, Elements of Ethereum		
	2.2	Ethereum mining, consensus mechanisms, Ethereum networks		
	2.3	Introduction to Smart Contract, Smart contract using Solidity on Ethereum		
	2.4	Scalability and security issues		
	2.5	Contract Development and Deployment on Ethereum test net		
3	Hyper Ledger		06	CO3
	3.1	Introduction to Hyperledger, permission vs permissionless		
	3.2	Hyperledger Fabric architecture - blockchain, chain code, and membership services, Components of fabric.		
	3.3	Enterprise Application using Hyperledger Fabric		
4	Multichain		05	CO4
	4.1	Introduction to MultiChain, Privacy, and Permissions in MultiChain.		
	4.2	Multichain Architecture, MultiChain: Consensus, Mining, Streams		
	4.3	Multiple configurable Blockchains using MultiChain		
5	Corda		05	CO4
	5.1	Introduction to Corda, Corda architecture		
	5.2	Corda components and development environment.		

		Self-Learning: Case studies on cryptography and security- Case Study 1-Virtual Elections Case Study 2-IP spoofing Attacks		
		Total	30	-

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Atul Kahate	<i>Cryptography And Network Security</i>	Tata Mc-Graw Hill	2nd Edition, 2008
2	Cryptography And Network Security	<i>Cryptography And Network Security</i>	Pearson India Education Pvt Ltd	1st Edition, 2016
3	Behrouz Fourouzan, Deepend Mukhopadhyay	<i>Cryptography and Network Security</i>	Tata McGraw Hill Education Private Limited	2nd Edition, 2011
4	William Stallings	<i>Cryptography and Network Security: Principles and Practice</i>	Pearson	5th Edition, 2011

Course Code	Course Title							
	Big Data 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	50	—	—	—	—	100

Course Prerequisites:

Database management system.

Course Objectives:

This course aims to provide an overview of the rapidly growing field of big data analytics, introducing essential tools like Hadoop, NoSQL, and MapReduce, which are crucial for managing and analyzing large-scale data. It will cover the fundamental techniques and principles necessary for achieving scalable and efficient big data analytics, including capabilities for real-time data streaming. By the end of the course, students will have developed the skills needed to solve complex, real-world problems, particularly in decision support contexts.

Course Outcomes:

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

- CO 1. Interpret the fundamental enabling techniques like Hadoop in achieving Big Data analytics.
- CO 2. Interpret the fundamental enabling techniques like No-SQL, MapReduce in achieving Big Data analytics.
- CO 3. Illustrate techniques used for finding similarity and study of different distance measures.
- CO 4. Interpret various stream data models and sample data in Stream.
- CO 5. Demonstrate the perspective of big data analytics and apply scalable algorithms on various applications.

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Module No.	Unit No.	Topics	Hrs.	CO	
1	Introduction to Big Data Analytics			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.	06		
	1.2	Introduction to Hadoop and its components			
	1.3	Hadoop ecosystem, physical architecture, Hadoop limitations			
2	NoSQL and mining large scale system			CO2	
	2.1	No-SQL, No-SQL business drivers, No-SQL case studies, NoSQL Data Architectural Patterns, Variations of NoSQL Architectural Patterns, Using NoSQL to Manage Big Data	08		
	2.2	MapReduce - MapReduce and The New Software Stack, The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.			
	2.3	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.			
3	Finding Similar Items			CO3	
	3.1	Applications of Near-Neighbor Search- Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem.	04		
	3.2	Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.			
4	Mining Data Streams			CO4	
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Query, Issues in Stream Processing	06		

	4.2	Sampling Data in a Stream: Obtaining a Representative Sample, The General Sampling Problem, Varying the Sample Size		
	4.3	Filtering Streams: The Bloom Filter, Analysis, Counting Distinct Elements in a Stream		
5	Link Analysis		06	CO5
	5.1	PageRank Definition, Structure of the web, dead ends, Using PageRank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector, Link spam, Topic-sensitive PageRank, Hubs and Authorities, Hyperlink-Induced Topic Search concept		
	5.2	Self-learning: Hyperlink-Induced Topic Search Algorithm		
Total			30	—

Recommended Books:

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

Course Code	Course Title							
	Business Analytics							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	02	0	0	02				
Credits Assigned	02	0	0	02				
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						100
	30	20	50	—	—	—	—	

Course Prerequisites:

Basic knowledge of statistics and probability, Python programming.

Course Objectives:

This course aims to equip students with a solid understanding of business analytics, empowering them to utilize data-driven insights for effective decision-making in the business world. Through a combination of theoretical knowledge and practical skills, students will learn to apply statistical techniques, leverage data mining and machine learning tools, work with big data technologies, and employ data visualization to extract meaningful insights from diverse datasets. By the end of the course, students will be well-prepared to tackle real-world business challenges and contribute value through data-driven solutions.

Course Outcomes:

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

- CO 1. Understand the core concepts and principles of business analytics.
- CO 2. Apply descriptive analytics techniques to summarize and visualize data effectively, enabling data-driven insights.
- CO 3. Analyze and evaluate predictive modeling and forecasting methods, including regression, classification, and time series analysis.
- CO 4. Apply prescriptive analytics methods for making informed decisions.
- CO 5. Apply business analytics to support strategic decision-making, manage risk, and evaluate ethical considerations in data-driven strategies.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Business Analytics		06	CO1
	1.1	Introduction, Evolution of Business Analytics, Role of Data-driven decision making		
	1.2	Data for Business Analytics, Datasets and Data Sources, Exploratory Data Analysis, Decision Models, Problem Solving with Analytics		
2	Descriptive Analytics		07	CO2
	2.1	Data Summary and Visualization, Descriptive Statistical Measures		
	2.2	Probability distributions and Data Modelling, Statistical Inference, Time Series Analysis		
3	Predictive Analytics		07	CO3
	3.1	Modelling Relationships and Trends in Data, Regression Analysis, Linear and Non-linear Regression Models, Time Series Forecasting		
	3.2	Introduction to Data Mining, Data Exploration and Reduction, Classification Techniques		
4	Prescriptive Analytics		06	CO4
	4.1	Linear Optimization, Formulating Optimization problems		
	4.2	Integer Optimization, Solving Models with General Integer Variables, Integer Optimization with Binary Variables, Mixed-Integer Optimization Models		
5	Decision Analysis		04	CO5
	5.1	Formulating Decision Problems, Decision Strategies without Outcome Probabilities, Decision Strategies with Outcome Probabilities, Decision Trees, Ethical Considerations		
Total			30	—

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	James R. Evans	<i>Business Analytics</i>	Pearson, India	3rd Edition, 2021
2	S. Christian Albright, Wayne L. Winston	<i>Business Analytics</i>	Cengage, India	7th Edition, 2022
3	Sanjiv Jaggia, Kevin Lertwachara	<i>Business Analytics: Communicating with Numbers</i>	McGraw Hill, India	2nd Edition, 2023
4	U. Dinesh Kumar	<i>Business Analytics: The Science of Data-Driven Decision Making</i>	Wiley, India	1st Edition, 2017

Course Code	Course Title							
	IoT Security							
	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	50	–	–	–	–	100

Course Prerequisites:

Networking, IoT devices.

Course Objectives:

The objective of the course is to gain a solid understanding of what IoT is, including the concept of interconnected devices and the potential security risks associated with IoT deployments. Learn to identify and classify various security threats and vulnerabilities specific to IoT ecosystems, such as device compromise, data breaches, and denial of service attacks. It also helps to understand how to secure IoT networks, including techniques for securing wireless communication and implementing firewalls and intrusion detection systems.

Course Outcomes:

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

- CO 1. Learn the fundamentals of Internet of Things and Architecture.
- CO 2. Understand and explore different IoT enabling technologies.
- CO 3. Understand and apply Threats and Attacks in IoT network.
- CO 4. Understand different recommended security approaches.
- CO 5. Apply privacy preservation for IoT and case studies.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Internet of Things		06	CO1
	1.1	IoT Conceptual Framework, Definition and Characteristics of IoT, Physical and Logical layer of IoT		
	1.2	IoT Architecture view, Internet connectivity Principles: Internet connectivity, Internet based communication, IP addressing in the IoT, Media Access Control, and Application Layer Protocols: HTTP, HTTPS, FTP, Telnet and others.		
2	IoT Enabling Technologies		07	CO2
	2.1	IoT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols		
	2.2	IoT Security Objectives and Standards, Security Development Life cycle, Barriers		
3	Threats and Attacks		07	CO3
	3.1	Phases of IoT System: Phase I (Data collection, Acquisition, Perception), Phase II (Storage), Phase III (Intelligent Processing), Phase IV (Data Transmission), Phase V (Delivery) IoT as Interconnection of Threats: Phase Attacks, Attacks as per Architecture, Attacks based on Components		
	3.2	Security Threats against IoT Embedded Devices and Systems, IoT Security Impacts against Mobile Networks		
4	Recommended Security Approaches		06	CO4
	4.1	Analyze privacy impacts to stakeholders and adopt a Privacy-by-Design approach to IoT development and deployment, Threat Modeling, Implement layered security protections to defend IoT assets, Define Life Cycle Security Controls for IoT devices		
	4.2	Implement data protection best practices to protect sensitive information, Data Management, Data Management.		
5	Privacy Preservation for IoT, Green IoT		04	CO5
	5.1	Smart building subsystems, IoT devices used in Smart buildings, Intelligence in smart buildings, Privacy of human behaviour, Privacy issues with wireless LAN, RFID		

	5.2	A secure Path Generation Scheme for Real-Time Green Internet of Things: Query plan in wireless sensor networks, Query processing and network model.		
		Total	30	–

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Raj Kamal	<i>Internet of Things “Architecture and Design”</i>	McGraw Hill Education, India	2018
2	Arshdeep Bahga, Vijay Madisetti	<i>Internet of Things “A hands-on approach”</i>	Universities Press (India)	2017
3	Fei Hu	<i>Security and Privacy in Internet of Things (IoTs) “Models, Algorithms and Implementation”</i>	CRC Press, Taylor & Francis Group	2016
4	Sridipta Misra, Salman Hashmi, Muthucumaru Maheswaran	<i>Security Challenges and Approaches in Internet of Things</i>	Springer	Sept 2016
5	Sebastien Ziegler	<i>Internet of Things Security and Data Protection</i>	Springer	2017

Course Code	Course Title					
116U40E824	Introduction to Cryptography and Network Security					
	TH	P	TUT	Total		
Teaching Scheme (Hrs.)	02	—	—	02		
Credits Assigned	02	—	—	02		
Examination Scheme	Marks					
	CA		ESE	TW	O	P
	ISE	IA	50	—	—	—
	30	20				100

Course Prerequisites:

Analog and Digital Communication, Information Theory, Data Communication Networking.

Course Objectives:

The objective of the course is to provide a deeper understanding of cryptography, its application to network security, threats/vulnerabilities to networks, and various approaches to encryption techniques. It covers traffic confidentiality, message authentication codes, and the Digital Signature Standard, while providing solutions for related issues.

Course Outcomes:

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

- CO 1. Learn basics of Network security issues.
- CO 2. Understand various Cryptography techniques.
- CO 3. Describe key cryptosystems and algorithms.
- CO 4. Understand Public Key Crypto systems.
- CO 5. Identify Network security with case studies.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Security		04	CO1
	1.1	Need for security, Security approaches, Principles of security, Types of Security Attacks, and Security services, Methods of defense, Security Mechanism.		
	1.2	Security trends, Techniques for security goals implementation, model for Network security.		
2	Cryptography: concepts and techniques		07	CO2
	2.1	Classical Encryption Techniques: Plain text and Cipher text, Substitute Techniques, Transposition Techniques, Steganography		
	2.2	Encryption and Decryption, Systematic and Asymmetric key Cryptography, key range and key size. Possible types of attacks.		
3	Cryptography Algorithm		08	CO3
	3.1	Symmetric key Algorithms: Algorithm types and Modes, Overview of symmetric key cryptography, Data Encryption Standard (DES), Advanced Encryption Standard (AES)		
	3.2	Asymmetric key algorithm, Overview of Asymmetric key Cryptography, RSA algorithm, Digital signature, Authentication protocols - digital signature standards (DSS)		
4	Public Key Cryptosystem		06	CO4
	4.1	Introduction to public key cryptosystem, attacks on RSA, concept of Brute-force attack, concept of Mathematical attack, concept of timing attack.		
	4.2	Key Management - Symmetric Key Distribution: centralized vs Distributed key management, key generation, key distribution		
5	Network Security		05	CO5
	5.1	Basics concepts, Application layer security, Web security, secure electronic transaction, Email security, secure HTTP, Applications of IP security, Firewall and VPN		
Total			30	—

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Atul Kahate	<i>Cryptography And Network Security</i>	Tata Mc-Graw Hill	2nd Edition, 2008
2	Cryptography And Network Security	<i>Cryptography And Network Security</i>	Pearson India Education Pvt Ltd	1st Edition, 2016
3	Behrouz Fourouzan, Debdeep Mukhopadhyay	<i>Cryptography and Network Security</i>	Tata McGraw Hill Education Private Limited	2nd Edition, 2011
4	William Stallings	<i>Cryptography and Network Security: Principles and Practice</i>	Pearson	5th Edition, 2011

Course Code	Course Title							
	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	50	—	—	—	—	100

Course Prerequisites:

Artificial Intelligence and Machine Learning (116U40C701), Python Programming (116U06L201), Theory of Automata (116U40C501).

Course Objectives:

The objective of the course is to impart knowledge 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, Machine Translation, Question Answering and Information Retrieval, Chatbots and Dialogue Systems.

Course Outcomes:

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

- CO 1. Learn the fundamentals of natural language processing.
- CO 2. Understand and explore the use of language modeling, POS tagging in NLP.
- CO 3. Understand and apply syntax analysis in NLP.
- CO 4. Understand the role of distributional and lexical semantics in NLP.
- CO 5. Apply NLP techniques to design real-world NLP applications.

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Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to NLP		07	CO1
	1.1	Natural language processing, Empirical laws, basic text processing, spelling correction		
	1.2	N-Gram Language Models, Advanced smoothing for language modeling, Computational & Finite - State Methods for Morphology		
2	POS tagging		04	CO2
	2.1	POS tagging, Hidden Markov Models in POS tagging, Viterbi decoding		
	2.2	Baum Welch algorithm, Maximum entropy models, Conditional random fields		
3	Syntax – Constituency Parsing		08	CO3
	3.1	Syntax - CKY, PCFGs		
	3.2	Dependency Grammars and Parsing, Transition based parsing, MST based Dependency Parsing		
	3.3	Distributional Semantics, Word Embeddings, Lexical Semantics, Word sense disambiguation & detection		
4	Models in NLP		07	CO4
	4.1	Topic Models, Latent Dirichlet Allocation, Gibbs Sampling for LDA, LDA Variants and Applications		
	4.2	Entity Linking, Information Extraction, Relation Extraction, Distant Supervision		
	4.3	Text Summarization, Text Classification, Sentiment Analysis and Opinion Mining, Aspect-Based Sentiment Analysis		
5	Applications and Recent trends in NLP		04	CO5
	5.1	Machine Translation, Question Answering and Information Retrieval, Chatbots and Dialogue Systems		
	5.2	Recent developments and emerging trends in NLP research		
Total			30	–

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Dan Jurafsky and James H. Martin	<i>Speech and Language Processing</i>	Pearson	2nd Edition, 2014
2	Nitin Indurkhy and Fred J. Damerau	<i>Handbook of Natural Language Processing</i>	Chapman & Hall/CRC	2nd Edition, 2010
3	Steven Bird, Ewan Klein, and Edward Loper	<i>Natural Language Processing with Python</i>	O'Reilly Media	1st Edition, 2009
4	Christopher D. Manning and Hinrich Schütze	<i>Foundations of Statistical Natural Language Processing</i>	MIT Press	1st Edition, 1999
5	Lane, Howard, and Hapkes	<i>Natural Language Processing in Action</i>	Manning	1st Edition, 2019

Course Code	Course Title					
	Real Time Operating Systems					
	TH	P	TUT	Total		
Teaching Scheme (Hrs.)	02	0	0	02		
Credits Assigned	02	0	0	02		
Examination Scheme	Marks					
	CA		ESE	TW	O	
	ISE	IA	50	—	—	
	30	20			—	100

Course Prerequisites:

Computer Programming concepts with C, Concepts in Embedded System Design.

Course Objectives:

This course aims at introducing concepts in the Real Time Operating System and its need in the development of Embedded Applications with a case study of FreeRTOS. Students will be able to understand and design real time operating systems which are the backbone of embedded industry.

Course Outcomes:

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

- CO 1. Discuss use of real time operating system features.
- CO 2. Use various task management utilities in RTOS to control various tasks in a system.
- CO 3. Explain memory allocation schemes and their use.
- CO 4. Develop small applications using interrupts and timer utilities in RTOS.
- CO 5. Apply RTOS functions for prevention of problems due to shared resources.

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Module No.	Unit No.	Details	Hrs.	CO
1	Overview of Operating System Concept		04	CO1
	1.1	Basics of operating systems, components of general-purpose OS, Real time concepts, hard real time and soft real time, Requirement of RTOS, difference between general-purpose operating system and real time OS.		
		*Installing and getting introduced to FreeRTOS worth 4 hours		
2	Task Management		06	CO2
	2.1	Multi-Tasking nature of embedded applications, Types of tasks, States of Tasks, Task Priorities, Task Precedence, Need of task Scheduling, Task scheduling algorithms: Clock driven and Event driven, Preemptive and Non Preemptive. Analysis of these with examples.		
	2.2	Task management in RTOS: Creating and Deleting tasks, suspending and resuming tasks, Utilities for task management in FreeRTOS. Queue Management, Characteristics of a queue, Using a queue using APIs to create Mailbox		
		*Laboratory work on Task Management and Queue Management worth 6 hours		
3	Memory Management		04	CO3
	3.1	Static and Dynamic Memory allocation concept, various allocation strategies, Case study of FreeRTOS dynamic memory allocation schemes		
		*Laboratory work on memory allocation worth 6 hours		
4	Interrupt and Timers in RTOS		06	CO4
	4.1	FreeRTOS API functions available in interrupt service routine. Deferred Interrupt Processing, Using Queues within an Interrupt service routine, Interrupt Nesting, Mutual Exclusion.		
	4.2	Concept of software timer, watchdog timer, Timer Service Task, Software Timer		
		*Laboratory work on Interrupts, and Timer applications worth 4 hours		

		Shared Resources and Inter Task Synchronization			06	CO5		
5	5.1	Types of Shared resources, Problems due to shared resources, deadlocks, priority inversion, etc., Use of Flags, Binary Semaphores, Counting Semaphores, Mutex, Monitors, Examples using utilities in FreeRTOS						
	5.2	Critical Sections and suspending the scheduler, Priority Inversion, Priority inheritance, Deadlock prevention, Event groups, Examples using utilities in FreeRTOS						
		*Laboratory work on IPC tools and Utilities worth 6 hours						
6	6.1	Comparative study of various RTOS			04	CO2, CO4, CO5		
Total					30	—		

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher (Country)	Year of Publication
1	Jim Cooling	<i>Real Time operating system: Book 1-The Theory</i>	LindenTree Associates	January 28, 2019
2	Shibu K V	<i>Introduction to Embedded Systems</i>	McGraw Hill Education	10th Edition, 2013
3	David E. Simon	<i>An Embedded Software Primer</i>	Pearson	15th Impression, 2013
4	Richard Barry	<i>Mastering the FreeRTOS Real Time Kernel: A Hands-On Tutorial Guide</i>	Real Time Engineers Ltd	Pre-release 161204 Edition, 2016

Course Code	Course Title					
	Project – II					
	TH	P	TUT	Total		
Teaching Scheme (Hrs.)	00	16	00	16		
Credits Assigned	00	08	00	08		
Examination Scheme	Marks					
	CA		ESE	TW	O	P
	ISE	IA	00	100*	100	–
	00	00				200

*Based on periodic assessment of progress of project

Course Outcomes:

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

- CO 1. Implement and test the hardware/software algorithms to meet desired Specifications
- CO 2. Analyze, interpret results and correspondingly modify the designed system to achieve Desired results.
- CO 3. Identify limitations of work done and suggest scope for future development.
- CO 4. Write a technical report on the work done in appropriate format.
- CO 5. Demonstrate individual, group and leadership skills during project execution

Term work:

The final year students have already undergone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I. Students are expected to report to the faculty advisor about the progress of the work. A continuous assessment record of the progress of the project will be maintained by concerned faculty members. The TW should be examined by approved internal faculty appointed by the head of the institute on the basis of following:

1. Scope and objective of the project work.
2. Extensive Literature survey.
3. Progress of the work (Continuous assessment)
4. Design, implementation, and analysis of the project work.
5. Results, conclusions and future scope.
6. A Technical Report in prescribed format.

An approved external examiner and internal examiner appointed by the head of the institute together will assess during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained.

Course Code	Course Title						
116U40L811	Artificial Intelligence Based Wireless Network Design Laboratory						
	TH	P	TUT	Total			
Teaching Scheme (Hrs.)	—	02	—	02			
Credits Assigned	00	01	—	01			
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	—	25	25	—	—
							50

Term work will consist of experiments covering the entire syllabus of “Artificial Intelligence Based Wireless Network Design” (116U40E811). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Introduction to Network Simulation Tools such as NS-3, OPNET, Cisco Packet Tracer, etc.
2. Study the behavior of wireless signal propagation and its impact on network design.
3. Implement AI-based resource allocation techniques in a wireless network.
4. Develop an AI-based intrusion detection system for a wireless network.
5. Optimize QoS in a wireless network using AI algorithms. Measure and compare QoS metrics in optimized vs. non-optimized scenarios.
6. Simulate network faults and develop AI-driven fault detection and recovery mechanisms.
7. Implement AI-based predictive analytics for network management using historical network performance data.
8. Analysis of present case studies of AI applications in real-world wireless networks.

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9. Mini project - Apply AI-based wireless network design concepts to a practical project. Develop, implement, and test AI solutions.

Course Code	Course Title							
	Deep Learning and Automation Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	0	2	0	2				
Credits Assigned	0	1	0	1				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Deep Learning and Automation” (116U40E812). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Image Classification using CNN
2. Predictive Maintenance using Time Series Data
3. Object Detection and Tracking for Robotics
4. NLP for Text Classification
5. GANs for Image Generation
6. Human Activity Recognition using Sensor Data
7. IoT Device Anomaly Detection
8. Ethical AI Experiment
9. Mini Project

Course Code	Course Title							
	High Performance Computing Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—		02	—	02			
Credits Assigned	00		01	—	01			
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “High Performance Computing” (116U40E813). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Setting up a development environment for parallel programming
2. Analyzing processor architectures and performance metrics.
3. Running a basic parallel program to understand the speedup achieved compared to the serial code.
4. Analyzing the performance of multi-core and multi-threaded architectures.
5. Writing CUDA kernels to perform vector operations (e.g., vector addition) and analyzing the performance gains on a GPU.
6. Parallelizing algorithms such as scan, reduction, and convolution using CUDA.
7. Implementing parallel algorithms for tasks like prefix-sum, parallel histogram, sparse matrix computation, and merge-sort on GPUs.
8. Analyzing dependency issues in parallel algorithms and mapping them onto parallel architectures.
9. Experimenting with latency-hiding and tolerating techniques to mitigate performance bottlenecks.

Course Code	Course Title						
	Speech Processing using Machine Learning Laboratory		TH	P	TUT	Total	
Teaching Scheme (Hrs.)			—	02	—	02	
Credits Assigned			00	01	—	01	
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	—	25	25	—	—
							50

Term work will consist of experiments covering the entire syllabus of “Speech Processing using Machine Learning” (116U40E814). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Write a program to read, write, record and play a given audio signal using MATLAB/Python.
2. Write a program for framing, windowing, segmenting, and filtering a given audio signal using MATLAB/Python.
3. Obtaining the Energy and Zero Crossing Rate (ZCR) of a given signal.
4. Determine the STFT and spectrogram of the given signal.
5. Write a program to estimate the pitch of a given signal using MATLAB/Python.
6. Write a program to find the LPC coefficient using covariance and correlation.
7. Write a program to find the MFCC coefficient of a given signal using MATLAB/Python.
8. Short-Time Cepstrum Analysis of Speech.

Course Code	Course Title						
	Wireless Sensor Network & IoT Laboratory						
	TH		P	TUT		Total	
Teaching Scheme (Hrs.)	—		02	—		02	
Credits Assigned	00		01	—		01	
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA			25	25	—

Term work will consist of experiments covering the entire syllabus of “Wireless Sensor Network & IoT” (116U40E815). Students will be graded based on continuous assessment of their term work.

Oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Implement a wireless sensor network (WSN) to acquire sensor data from the wireless sensor board and external sensors (e.g., dielectric moisture sensor, rain gauge, temperature sensor, humidity sensor) using VLAB.
2. Familiarization with MSP430 and perform necessary software installation. Energia programming basic example of LED blinking.
3. Familiarization with Arduino IoT platform. Simulating basic examples using Tinkercad.
4. Interface DHT11 sensor with MSP430 and write a program to print temperature and humidity readings.
5. Interface Bluetooth with MSP430 and write a program to turn LED ON/OFF when ‘1’/‘0’ is received from smartphone using Bluetooth.
6. WSN implementation using Omnet simulator.
7. MQTT protocol (used for IoT) implementation.

Course Code	Course Title							
	Blockchain Technology Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—	02	—	02				
Credits Assigned	—	01	—	01				
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Blockchain Technology” (116U40E816). Students will be graded based on continuous assessment of their term work.

Oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Creation of Block
2. Blockchain implementation
3. Creating Merkle Tree
4. Blockchain implementation using Merkle Trees
5. Creating ERC20 token
6. Mining in Blockchain
7. Peer-to-peer implementation using Blockchain
8. Creating Cryptocurrency Wallet

Course Code	Course Title							
	Big Data Analytics Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—	02	—	02				
Credits Assigned	00	01	—	01				
Examination Scheme	Marks							
	CA		ESE	TW	O	P		
	ISE	IA				P&O		
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Big Data Analytics” (116U40E821). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Descriptive Analysis of data: Summary statistics, Data visualization, and Data profiling
2. Data Collection and Preprocessing using Python libraries
3. Data Storage and Management using Hadoop Distributed File System (HDFS). Explore NoSQL database storage and query techniques
4. Use of MapReduce to process and analyze large datasets
5. Data Visualization for web applications using Python libraries
6. Study of Big Data Tools and Frameworks: Apache Kafka, Apache Flink, Apache Cassandra
7. Calculate the PageRank of web pages using the original PageRank algorithm
8. Visualize the link structure of a website or network using graph visualization tools
9. Identify hubs and authorities in a web network using the HITS algorithm
10. Implement PageRank in distributed data processing frameworks like Hadoop or Spark

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11. Mini Project: Apply big data analytics knowledge to a real-world project

Course Code	Course Title							
	Business Analytics Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	0	2	0	2				
Credits Assigned	0	1	0	1				
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Business Analytics” (116U40E822). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Data Cleaning and Pre-processing
2. Exploratory Data Analysis
3. Regression Analysis
4. Classification Models
5. Time Series Forecasting
6. Text Analysis and Sentiment Analysis
7. Optimization Modelling
8. Decision Analysis
9. Dashboard Creation
10. Mini Project

Course Code	Course Title						
	IoT Security Laboratory						
	TH	P	TUT	Total			
Teaching Scheme (Hrs.)	—	02	—	02			
Credits Assigned	00	01	—	01			
Examination Scheme	Marks						
	CA		ESE	TW	O	P	
	ISE	IA			25	25	P&O
	—	—	—	—	—	—	50

Term work will consist of experiments covering the entire syllabus of “IoT Security” (116U40E823). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

List of Experiments:

1. Packet Sniffing and Analysis
2. Vulnerability Scanning
3. IoT Device Authentication
4. IoT Firmware Analysis
5. Authentication Bypass
6. Denial of Service (DoS) Attacks
7. Man-in-the-Middle (MitM) Attacks
8. Real-World IoT Attack Simulations
9. IoT Device Encryption

Course Code	Course Title						
116U40L824	Introduction to Cryptography and Network Security Laboratory						
	TH	P	TUT	Total			
Teaching Scheme (Hrs.)	—	02	—	02			
Credits Assigned	00	01	—	01			
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O
	ISE	IA	—	25	25	—	—
							50

Term work will consist of experiments covering the entire syllabus of “Introduction to Cryptography and Network Security” (116U40E824). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

List of Experiments:

1. Caesar Cipher: Implement Caesar Cipher for basic encryption and decryption.
2. DES Encryption: Encrypt/decrypt messages using DES with ECB and CBC modes.
3. AES Encryption: Implement AES encryption with different key sizes.
4. RSA Algorithm: Use RSA for secure encryption/decryption.
5. ElGamal Encryption: Implement the ElGamal encryption system.
6. Diffie-Hellman Key Exchange: Simulate secure key exchange using Diffie-Hellman.
7. MD5 Hashing: Hash messages with MD5 and observe the avalanche effect.
8. SHA-256 Hashing: Demonstrate SHA-256 message hashing.
9. Digital Signature with RSA: Sign and verify messages using RSA.
10. Digital Certificates: Simulate the creation of a basic digital certificate.
11. Image Steganography: Hide messages within an image using LSB technique.

12. Audio Steganography: Conceal data in audio files.
13. ARP Spoofing: Simulate and detect ARP spoofing.

Course Code	Course Title							
	Natural Language Processing Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—		02	—	02			
Credits Assigned	00		01	—	01			
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Natural Language Processing” (116U40E825). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

Tentative List of Experiments:

1. Preprocessing of text (Tokenization, Filtration, Script Validation, Stop Word Removal, Stemming)
2. Study of Morphological Analysis
3. Implementing Stemming And Lemmatization
4. Implementing N-gram model and N-gram model smoothing
5. Part-of-Speech (POS) tagging - HMM and Viterbi decoding
6. Chunking to extract noun phrases
7. Named Entity Recognition on a given text
8. Virtual Lab on Word Generator
9. Case-based study on information retrieval
10. Sentiment Analysis of tweets from Twitter
11. Mini Project on real-life NLP Applications

Course Code	Course Title							
	Real Time Operating Systems Laboratory							
	TH	P	TUT	Total				
Teaching Scheme (Hrs.)	—		02	—	02			
Credits Assigned	00		01	—	01			
Examination Scheme	Marks							
	CA		ESE	TW	O			
	ISE	IA			P	P&O	Total	
	—	—	—	25	25	—	—	50

Term work will consist of experiments covering the entire syllabus of “Real Time Operating Systems” (116U40E826). Students will be graded based on continuous assessment of their term work.

Practical and oral examination will be based on laboratory work and the entire syllabus.

List of Experiments:

1. Installing and getting introduced to FreeRTOS
2. Task Management
3. Process Management
4. Queue Management
5. Memory allocation
6. Interrupts
7. Timer applications
8. Semaphores, Mutex
9. Mailbox
10. Deadlock and Priority Inversion