SYLLABUS

B. Tech.

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

2024 SCHEME

Semester V & VI

SEMESTER – V

FIFTH SEMESTER (July-December)														
Sl. No:	Slot	Course Code	Course Type	Course Category	Course Title (Course Name)	Credit Structure				SS	Total Marks		Credits	Hrs./ Week
						L	T	P	R		CIE	ESE		
1	A	24SJPCCST501	PC	PC	Computer Networks	3	1	0	0	5	40	60	4	4
2	B	24SJPCADT502	PC	PC	Robotics and Intelligent Systems	3	1	0	0	5	40	60	4	4
3	C	24SJPCCST503	PC	PC	Machine Learning	3	0	0	0	4.5	40	60	3	3
4	D	24SJPBADT504	PC-PBL	PB	Big Data Analytics	3	0	0	1	5.5	60	40	4	4
5	E	24SJPEADT52N	PE	PE	PE-2	3	0	0	0	4.5	40	60	3	3
6	I*	24SJICHUM506	HMC	IC	Constitution of India (MOOC)	-	-	-	-	2	-	-	1	-
7	L	24SJPCADL507	PCL	PC	Robotics Lab	0	0	3	0	1.5	50	50	2	3
8	Q	24SJPCCDL508	PCL	PC	Data Analytics Lab	0	0	3	0	1.5	50	50	2	3
9	R/M/H		VAC		Remedial/Minor/Honours Course	3	1	0	0	5			4*	4*
	S_5/ S_6	Industrial Visit (Maximum 6 Days are permitted, Not Exceeding more than 4 Working Days) /Industrial Training												
Total										**30/ 35**			**23/27***	**24/28***

No Grade Points will be awarded for the MOOC course and I slot course.

Industrial Training: *Students who are not participating in the industrial visit must attend industrial training during that period.*

SEMESTER S5

COMPUTER NETWORKS

Course Code	**24SJPCCST501**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the core concepts of computer networking.
2. To develop a big picture of the internetworking implementation on Linux-based systems.
3. To impart an overview of network management concepts.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Overview of the Internet, Protocol layering (Book 1 Ch 1) Application Layer: Application-Layer Paradigms, Client-server applications - World Wide Web and HTTP, FTP. Electronic Mail, DNS. Peer-to-peer paradigm - P2P Networks, Case study: BitTorrent (Book 1 Ch 2)	6
2	Transport Layer: Services, Protocols, UDP, TCP (Book 1 Ch 3). ***Hands-on: Sockets Introduction, Elementary TCP Sockets, TCP Client/Server Example, I/O Multiplexing: The select and poll Functions (Book 2 Ch 3 to 6), Elementary UDP Sockets (Book 2 Ch 8), Advanced I/O Functions (Book 2 Ch 14)*** Network Layer: Introduction, Network-layer protocols, Unicast routing, Multicast routing - Multicasting Basics, Intra domain and inter-domain routing, Next generation IP (Book 1 Ch 4), Quality of Service (Book 1 Ch 8) ***Hands-on: Linux Kernel Implementation of Routing Table and Caches, Routing Cache Implementation Overview, Adding new entry in the Routing Table using ip command (Book 3 Ch 14)***	18

3	Data-Link Layer: Data link control (DLC), Multiple access protocols (MAC), Link-layer addressing, Ethernet protocol, Connecting devices (Book 1 Ch 5) Wireless LANs, Mobile IP (Book 1 Ch 6) ***Hands-on: Datalink Provider Interface, SOCK_PACKET and PF_PACKET (Book 2 Ch 29)***	**11**
4	SNMP, ASN.1 (Book 1 Ch 9) Physical Layer: Data and signals, Digital transmission, Analog transmission, Bandwidth utilization, Transmission media (Book 1 Ch 7)	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the internetworking design in terms of protocol stack and the role of various application layer protocols	**K2**
CO2	Illustrate the functions of the transport layer from connectionless and connection-oriented perspectives, identify how the network layer achieves host-to-host connectivity and caters to the diverse service requirements of the host applications	**K3**
CO3	Explain the nuances of the data link layer design and demonstrate the various data link link layer protocols	**K3**
CO4	Describe the fundamental characteristics of the physical layer and understand how the physical layer supports the functionalities of the top layers	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3										3
CO2	3	2			2						3
CO3	3	2									3
CO4	3										3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networks: A Top-Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017
2	Unix Network Programming, Volume 1: The Sockets Networking API	W. Richard Stevens, Andrew M. Rudoff, Bill Fenner	Pearson Education	3/e, 2004
3	TCP/IP Architecture, design, and implementation in Linux	Sameer Seth M. Ajaykumar Venkatesulu	Wiley	1/e, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networking: A Top-Down Approach Featuring Internet	J. F. Kurose and K. W. Ross	Pearson Education	8/e, 2022
2	Computer Networks, A Systems Approach	L. L. Peterson and B. S. Davie	Morgan Kaufmann	5/e, 2011

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLbRMhDVUMngf-peFloB7kyiA40EptH1up&si=Z5UvbPE8rkmxXqhj

SEMESTER S5

ROBOTICS AND INTELLIGENT SYSTEMS

Course Code	**24SJPCADT502**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To Understand the concepts of manipulator and mobile robotics
2. To enable the learner to choose the suitable sensors, actuators and control for robot design
3. To equip the learners to develop kinematic model of mobile robot and understand robotic vision intelligence.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to robotics - Degrees of freedom, Robot types- Manipulators- Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots- wheeled, legged, aerial robots, underwater robots, surface water robots. Dynamic characteristics- speed of motion, load carrying capacity & speed of response. Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and Passive grippers. Ethics in robotics - 3 laws - applications of robots.	11
2	Sensors, Actuators and Control) Sensor classification- touch, force, proximity, vision sensors. Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non-contact type; Digital Camera - CCD camera - CMOS camera - Omnidirectional cameras Sensor characteristics. Actuators - DC Motors - H-Bridge - Pulse Width Modulation - Stepper Motors - Servos, Hydraulic & pneumatic actuators.	11

3	Robotic Vision: Sensing, Pre-processing, Segmentation, Description Recognition, Interpretation, Feature extraction -Camera sensor hardware interfacing. Representation of Transformations - Representation of a Pure Translation - - Pure Rotation about an Axis - Combined Transformations - Transformations Relative to the Rotating Frame. Basic understanding of Differential-Drive Wheeled Mobile Robot, Degree of mobility - different wheel configurations, holonomic and nonholonomic robots. Omnidirectional Wheeled Mobile Robots.	**11**
4	Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization - Continuous representations - Decomposition strategies - Current challenges in map representation. Probabilistic map-based localization (only Kalman method), Autonomous map building, Simultaneous localization and mapping (SLAM) - Mathematical definition and various types of SLAM -, Path Planning- Graph search, deterministic graph search -, breadth first search - depth first search- Dijkstra' s algorithm, A*, D* algorithms, Potential field based path planning. Obstacle avoidance - Bug algorithm - Vector Field Histogram - Dynamic window approaches. Navigation Architectures - Modularity forcode reuse and sharing - Control localization.	**11**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concepts of manipulator and mobile robotics.	**K2**
CO2	Choose the suitable sensors, actuators and control for robot design.	**K3**
CO3	Developing kinematic models of mobile robots and understanding robotic vision intelligence.	**K3**
CO4	Discover the localization and mapping methods in robotics and plan the path and navigation of the robot by applying an artificial intelligence algorithm.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2				2	2					2
CO2	2	2			3						3
CO3	3	3		3	2	3					3
CO4	2			3	3	3					3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Autonomous Mobile Robots	R Siegwart, IR Nourbakhsh, D Scaramuzza	MIT Press	2/e, 2011
2	Embedded Robotics, Mobile Robot Design and Applications with Embedded Systems	Thomas Bräunl	Springer	3/e, 2006
3	Introduction to Mobile Robot Control	S.G. Tzafestas	Elsevier	1/e, 2014
4	Artificial Intelligence for Robotics	Francis X. Govers	Packt	1/e, 2018
5	Introduction to Robotics - Analysis, Control, Applications	Saeed B. Niku	Wiley	2/e, 2011
6	Industrial Robotics - Technology, Programming and Applications	Mikell P Groover	McGraw Hill	2/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Robotics	John J. Craig	Pearson Education	3/e, 2005
2	Introduction to Robotics	S. K. Saha	TATA McGraw Hills	2/e, 2014
3	Robotics, Vision and Control - Fundamental Algorithms in MATLAB	Peter Corke	Springer-Verlag	1/e, 2021

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtu.be/xrwz9IxpMJg
2	https://youtu.be/sCTgZv33tuA
3	https://www.youtube.com/watch?v=nAwVfwSHAP0
4	https://www.youtube.com/watch?v=bBPeV5Bee7k

SEMESTER S5

MACHINE LEARNING

Course Code	**24SJPCCST503**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To impart the fundamentals principles of machine learning in computer and science.
2. To provide an understanding of the concepts and algorithms of supervised and unsupervised learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to ML:-** Machine Learning vs. Traditional Programming, Machine learning paradigms - supervised, semi-supervised, unsupervised, reinforcement learning. Parameter Estimation - Maximum likelihood estimation (MLE) and maximum aposteriori estimation (MAP), Bayesian formulation. **Supervised Learning:-** Feature Representation and Problem Formulation, Role of loss functions and optimization Regression - Linear regression with one variable, Linear regression with multiple variables: solution using gradient descent algorithm and matrix method.	9

2	**Classification** - Logistic regression, Naïve Bayes, KNN, Decision Trees – ID3 Generalisation and Overfitting - Idea of overfitting, LASSO and RIDGE regularization, Idea of Training, Testing, Validation Evaluation measures – Classification - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve (ROC), Area Under Curve (AUC). Regression - Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination.	**9**
3	SVM – Linear SVM, Idea of Hyperplane, Maximum Margin Hyperplane, Non-linear SVM, Kernels for learning non-linear functions Neural Networks (NN) - Perceptron, Neural Network - Multilayer feed-forward network, Activation functions (Sigmoid, ReLU, Tanh), Back propagation algorithm.	**9**
4	**Unsupervised Learning** Clustering - Similarity measures, Hierarchical Clustering - Agglomerative Clustering, partitional clustering, K-means clustering Dimensionality reduction - Principal Component Analysis, Multidimensional scaling Ensemble methods - bagging, boosting; Resampling methods - Bootstrapping, Cross Validation. Practical aspects - Bias-Variance tradeoff.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate Machine Learning concepts and basic parameter estimation methods.	**K2**
CO2	Demonstrate supervised learning concepts (regression, classification).	**K3**
CO3	Illustrate the concepts of Multilayer neural network and Decision trees	**K3**
CO4	Describe unsupervised learning concepts and dimensionality reduction Techniques and use appropriate performance measures to evaluate machine learning models	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								3
CO2	3	3	3								3
CO3	3	3	3								3
CO4	3	3	3								3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	4/e, 2020
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki Wagner Meira	Cambridge University Press	1/e, 2016
3	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1/e, 1998

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Applied Machine Learning	M Gopal	McGraw Hill	2/e, 2018
2	Machine Learning using Python	Manaranjan Pradhan U Dinesh Kumar	Wiley	1/e, 2019
3	Machine Learning: Theory and Practice	M.N. Murty, V.S. Ananthanarayana	Universities Press	1/e, 2024

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&si=GkLRvqazO3QOcZac

SEMESTER S5

BIG DATA ANALYTICS

Course Code	**24SJPBADT504**	**CIE Marks**	60
Teaching Hours/Week (L: T: P: R)	3:0:0:1	**ESE Marks**	40
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJICEST105 24SJPBADT304	**Course Type**	Practical

Course Objectives:

1. To understand the need of a framework to store and process the big data.
2. To have knowledge on the Big Data Technologies for processing the Different types of Data.
3. To understand the advanced framework for faster accessing and processing of Big Data.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Hadoop Distributed File System** Introduction to Big data, Conventional Data vs Big data, Big data architecture, Big data platforms. - Hadoop Ecosystem, Core Components, HDFS- Architecture, Using HDFS Files, HDFS Design, Blocks, Name nodes and Data nodes, Basic File system Operations, Hadoop Specific File Types, Anatomy of a file read and file write. Data Processing with MapReduce: Execution Pipeline-Map Reduce: Developing a map-reduce application	**12**
2	**Pig:** Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. **Hive:** Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase: HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.	**12**

3	**Introduction to R –** Overview of modern data analytic tools, Introduction to R, R Graphical User Interfaces - Features of R Language, Vectors, Filtering, Creating Matrices, Applying Functions to Matrix Rows and Columns, Lists, Creating List, General List Operations, Data Frames, Creating Data Frames, Matrix like Operations in Frames, Applying Functions to Data Frames, Reading and Writing Files.	**12**
4	**Overview of Spark –** Hadoop Overview of Spark – Hadoop vs. Spark – Cluster Design – Cluster Management – performance, Application Programming interface (API): Spark Context, Resilient Distributed Datasets, Creating RDD, RDD Operations, and Saving RDD - Lazy Operation – Spark Jobs. Writing Spark Application - Spark Programming in Python, R, Java - Application Execution	**12**

Suggestion on Project Topics

- Search Engine Optimization, Social Media Reputation Monitoring, Equity Research, Detection of Global Suicide rate, Find the Percentage of Pollution in India, Analyze crime rate in India, Health Status Prediction, Anomaly Detection in cloud server, Tourist Behaviour Analysis, BusBest- Not limited to above topics

Course Assessment Method (CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	**30**	**12.5**	**12.5**	**60**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 subdivisions. • Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate the Hadoop framework, focusing on the Hadoop Distributed File System (HDFS) and MapReduce.	**K3**
CO2	Simulate various Big data technologies like Pig, Hive, Hbase	**K3**
CO3	Resolve problems associated with big data with the features of R programming	**K3**
CO4	Demonstrate spark programming with different programming Languages and develop and Implement innovative ideas on big data technologies	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2							3
CO2	3	2	2	2							3
CO3	3	2	2	2							3
CO4	3	2	3	3			2		3		3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Hadoop: The Definitive Guide	Tom White	O'reilly Media	4/e, 2015
2	Professional Hadoop Solutions	Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich	Wrox Press	1/e, 2014
3	The Art of R Programming: A Tour of Statistical Software Design	Norman Matloff	NoStarch Press	1/e,2011
4	Spark in Action	Jean-Georges Perrin	O'Reilly Media	1/e, 2020
5	Mastering Apache Spark	Mike Frampton	Packt Publishing	1/e, 2015
6	Machine Learning with Spark	Nick Pentreath	Pract Publishing	1/e. 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Big Data Fundamentals: Concepts, Drivers & Techniques	Thomas Erl, Wajid Khattak, and Paul Buhler	Pearson India Education Service Pvt. Ltd	1/e, 2016
2	Programming Pig Dataflow Scripting with Hadoop	Alan Gates	O'Reilly Media, Inc	1/e, 2011
3	Programming Hive	Jason Rutherglen, Dean Wampler, Edward Caprialo	O'ReillyMedia Inc	1/e, 2012
4	Big Data	Black Book TM	DreamTech Press	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	Big Data Computing: https://youtube.com/playlist?list=PLFW6lRTa1g813IyYHLRP_bWJEKQDeEcSP&si=P21tW7vYsiVFr-Pg
2	Advanced R Programming for Data Analytics in Business: https://youtube.com/playlist?list=PLFW6lRTa1g831_jgArmLd-IwZd--UYz7F&si=fre0UvNAOGvbStkz
3	Social Network Analysis: https://youtube.com/playlist?list=PLyqSpQzTE6M_bqqS9VmsoFNtcS72EDhUV&si=YQ5AL0X5Tp1Rnq9l

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

1. **Project Planning and Proposal (5 Marks)**

   - Clarity and feasibility of the project plan
   - Research and background understanding
   - Defined objectives and methodology

2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**

   - Individual contribution to the presentation
   - Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**

   - Active participation and individual contribution
   - Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**

   - Adherence to the project timeline and milestones
   - Application of theoretical knowledge and problem-solving
   - Final Result

5. **Final Presentation (5 Marks)**

   - Quality and clarity of the overall presentation
   - Individual contribution to the presentation
   - Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**

   - Overall quality and technical excellence of the project
   - Innovation and originality in the project
   - Creativity in solutions and approaches

SEMESTER S5

ROBOTICS LAB

Course Code	**24SJPCADL507**	**CIE Marks**	50
Teaching Hours/Week (L: T: P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Lab

Course Objectives:

1. To provide students with exposure to the common sensor and actuator interfacing, setting up mobile robots and familiarising intelligent systems.

Note:

- *A minimum of ten experiments must be completed as part of the course requirements.*
- *Students are instructed to submit only the fair record for both Continuous Internal Evaluation (CIE) and End Semester Examinations (ESE). Rough records are not required.*

Expt. No.	Experiments
PART A	
1	Familiarisation of Arduino IDE, Arduino microcontroller I/O interfacing (LED, LCD, Serial Monitor)
2	Interfacing IR and Ultrasonic sensor with Arduino
3	Interfacing DC motors with arduino - speed and direction control
4	Interfacing Servo Motors with Arduino - angle of rotation
5	Familiarisation of Rasberry Pi and its I/O interfacing
6	Mobile Robot assembly
7	Networking with Arduino using BLE
PART B	
8	Writing a Simple Publisher and Subscriber, Simple Service and Client, Recording and playing back data, Reading messages from a bag file (Python/C++)
9	Localization of a mobile robot using LIDAR (ROS)

10	Implementing a weather station using Raspberry pi
11	Line following Robot using IR sensor
12	Image Recognition using ESP32 CAM module
13	Image processing using Raspberry pi
14	Obstacle avoidance of a mobile robot while moving to a point.
15	Navigation simulation using turtlebot in ROS

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/ Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Interface different peripherals to Arduino and Rasberry Pi.	**K3**
CO2	Assemble a mobile robot with different sensors and actuators	**K3**
CO3	Familiarise about localisation of mobile robots.	**K3**
CO4	Impart intelligence to robot using standard algorithms and familiarise the robot navigation.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2									2
CO2	2	2									3
CO3	2	2			2						3
CO4	2	3	3	3	3						3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Autonomous Mobile Robots	Siegwart, Roland	MIT Press,	2/e, 2004
2	Robotics, Vision and Control: Fundamental Algorithms in MATLAB,	Peter Corke	Springer	2021
3	Introduction to Robotics	John G Craig	Pearson Education Asia	2002
4	Introduction to Robotics	SK Saha	Mc Graw Hill Education	2004
5	Robotics and Control	RK Mittal and I J Nagrath	Tata McGraw Hill	2003
6	Robotic Tactile Sensing	Dahiya Ravinder S., Valle Maurizio	Springer	2013
7	https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/			

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S5

DATA ANALYTICS LAB

Course Code	**24SJPCCDL508**	**CIE Marks**	50
Teaching Hours/Week (L: T: P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCCST503	**Course Type**	Lab

Course Objectives:

1. To impart the knowledge on the Big Data Technologies for processing the Different types of Data. Configure Hadoop and perform File Management Tasks
2. To enable the learner to analyze big data using machine learning techniques

Note:

- *A minimum of ten experiments must be completed as part of the course requirements.*
- *Students are instructed to submit only the fair record for both Continuous Internal Evaluation (CIE) and End Semester Examinations (ESE). Rough records are not required.*

Expt. No.	Experiments
1	Set up and install Hadoop and explore the various shell commands in Hadoop and implement file management tasks.
2	Implement a word count program using Map Reduce to find the number of occurrences of specific keywords from an input file.
3	Using the structure of the Word Count program, write a Hadoop program that calculates the average word length of all words that start with each character.
4	Write a Map Reduce program for removing stop words from the given text files
5	Implement matrix multiplication with Hadoop Map Reduce
6	Implement Pig Latin scripts to sort, group, join, project, and filter data.
7	Implementing Database Operations on Hive
8	Write an R program to find the factorial and check for palindromes.
9	Implement a program to find variance, covariance and correlation between different types of attributes
10	Write an R program to solve linear regression and make predictions.
11	Write an R program to solve logistic regression.
12	Implement SVM and Decision tree Classifier using R
13	Implement KNN and Naive Bayes Classifier using R

14	Implement a Spark program that does the following: i) Count the total number of observations included in the dataset ii). Count the number of years over which observations have been made iii) Display the oldest and the newest year of observation
15	Implement clustering techniques using SPARK.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Configure Hadoop and perform File Management Tasks	**K3**
CO2	Implement different tasks using Hadoop Map Reduce programming model	**K3**
CO3	Apply different data processing tools like Pig and Hive to real time issues like weather dataset and sales of a company	**K3**
CO4	Implement data extraction from files and analyze big data using machine learning techniques in R and Illustrate the knowledge of Spark to analyze data in real-life scenarios.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3				3		2		1		3
CO2	3	3	2	1	3		2		1		3
CO3	3	3	2	1	3		2		1		3
CO4	3	3	2	1	3		2		1		3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mastering Apache Spark	Mike Frampton	Packt Publishing	1/e,2015
2	Hadoop: The Definitive Guide	Tom White	O'reilly Media	4/e, 2015
3	Machine Learning with Spark	Nick Pentreath	Pract Publishing	1/e, 2015
4	Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large Scale Data Analysis	Mohammed Gulle	Apress	1/e.2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Big Data Fundamentals: Concepts, Drivers & Techniques	Thomas Erl, Wajid Khattak, and Paul Buhler	Pearson	1/e,2016
2	Programming Pig Dataflow Scripting with Hadoop	Alan Gates	O'Reilly	1/e. 2011
3	Programming Hive	Jason Rutherglen, Dean Wampler, Edward Caprialo	O'Reilly	1/e, 2012
4	BIG DATA	Black Book TM	DreamTech	1/e,2016

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	Big Data Computing: https://youtube.com/playlist?list=PLFW6lRTa1g813IyYHLRP_bWJEKQDeEcSP&si=-Tf1nW5V1lD68oNU
2	Data Science on Apache Spark. Databricks. https://youtu.be/-5yf4vCUsbQ
3	Advanced R Programming for Data Analytics in Business: https://youtu.be/JEbD-Npl0kk?si=JCkxdXgEq5-ksfw0

Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**

- Completeness, clarity, and accuracy of the lab record submitted

PROGRAM ELECTIVE - 2

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
E	24SJPECST521	Software Project Management	3-0-0-0	3	3
	24SJPEADT522	Business Analytics	3-0-0-0		3
	24SJPEADT523	Information Systems	3-0-0-0		3
	24SJPECST524	Data Compression	3-0-0-0		3
	24SJPEADT526	Computational Biology	3-0-0-0		3
	24SJPECST527	Computer Graphics and Multimedia	3-0-0-0		3
	24SJPECST528	Advanced Computer Architectures	3-0-0-0		3
	24SJPEADT525	Fundamentals of Digital Image Processing	3-0-0-0		**5/3**

SEMESTER S5

SOFTWARE PROJECT MANAGEMENT

Course Code	**24SJPECST521**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs.30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To learn the techniques to effectively plan, manage, execute, and control projects within time and cost targets with a focus on Information Technology and Service Sector.
2. To learn agile project management techniques such as Scrum and DevOps.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Project scheduling and feasibility study: -** Project Overview and Feasibility Studies - Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal; Project Scheduling - Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.	**8**
2	**Resource Scheduling, Cost Control and Project management Features:-** Cost Control and Scheduling - Project Cost Control (PERT/Cost), Resource Scheduling & Resource Levelling; Project Management Features - Risk Analysis, Project Control, Project Audit and Project Termination.	**8**
3	**Agile Project Management:-** Agile Project Management - Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL). Other Agile Methodologies - Introduction to XP, FDD, DSDM, Crystal.	**9**

4	**Scrum and DevOps in project management:-** Scrum - Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum, Case Study; DevOps - Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and Test-Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring, Case Study.	**11**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand how effectively plan, and schedule projects within time and cost targets	**K2**
CO2	Apply project estimation and evaluation techniques to real world problem	**K3**
CO3	Discuss different Agile Project Methodologies	**K2**
CO4	Apply various SCRUM practices in project management and demonstrate the techniques used in DevOps.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3							2	2
CO2	3	3	3							2	2
CO3	3	3	3							2	2
CO4	3	3	3							2	2

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Succeeding with Agile: Software Development Using Scrum	Mike Cohn	Addison-Wesley	1/e, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Agile Product Management with Scrum	Roman Pichler	Addison-Wesley	1/e, 2010
2	Agile Project Management with Scrum	Ken Schwaber	Microsoft Press	1/e, 2004

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLLy_2iUCG87CBuNhvti0h6W54ZmqrSDMJ&si=L0S6yCyUT6mtG50o
2	https://www.youtube.com/watch?v=TPEgII1OilU
3	https://www.youtube.com/watch?v=7Bxdds2siU8

SEMESTER S5

BUSINESS ANALYTICS

Course Code	**24SJPEADT522**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To assist the student in gaining a basic understanding of Business Analytics and its application in various functional areas.
2. To introduce the concepts in business analytics, Statistical models, Data Modelling with Tableau and Web analytics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Business Analytics**-Evolution and scope, resource alignment within organization. Applications of business analytics – finance, sensitivity analysis, human resource management, market share estimation, recovery management, risk management, portfolio stress testing, fraud detection and prediction. Decision models, types - descriptive, diagnostic, predictive, and prescriptive. Data Modelling Approach - Data Organisation, Structured Vs Unstructured data, the 5 V's of Business Analytics, Data Analytics framework, Analytics Tools – licensed vs open source. Data cleaning, outliers and outlier's diagnostics.	8
2	**Statistical Models**- Probability Distributions, Sampling and Sampling Distributions, Statistical Distributions - Normal, Binomial, Poisson. Measures of Central Tendency, Symmetry, and Correlation. Time Series analysis – definition, steps to analyse, importance, components, models and techniques. Forecasting - Forecasting for Management Decisions, Data Patterns and Choice of Forecasting Techniques, Data Collection and Analysis in Forecasting, Forecasting with Smoothing Techniques, Forecasting with Regression.	8

3	**Data Modelling with Tableau**-Extracting data into Tableau – design flow, file types, data types, data sources, data preparations, dimensions, custom data view, extracting and editing data, transformation of variables, joining and blending data, tableau worksheets, tableau calculations, sort and filters, working with charts, exporting visualizations, formatting and forecasting.	**6**
4	**Web Analytics**-A|B Testing, Market Basket Analysis, Classification and Regression Tree, Monte Carlo Simulation. Click stream analytics, anonymous vs. registered user's analysis, Social Media Analytics - User generated content – Page tagging, Server log files, Data abstractions. Sentiment Analysis, Analytics in digital decoding consumer intent, decoding customer sentiments from comments, Text mining from opinion platforms **Data Science Toolkits for Business Analytics Clustering** - K-Means, DBSCAN, Agglomerative and Hierarchical, Decision Tree – ID3, Factor Analysis, and Segmentation Analysis. Build spread sheet models, analysis using spread sheets – What-if analysis, Break even analysis.	**14**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the various business analytical concepts, applications and models.	**K2**
CO2	Make use of statistical models for business analytics in data management.	**K3**
CO3	Apply tableau tool for business analytics applications.	**K3**
CO4	Make use of business analytical tools and techniques in Web Analytics and Demonstrate business analysis with data science toolkits.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3										3
CO2	3	3	2	2							3
CO3	3	3	2	2							3
CO4	3	3	2	2							3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Business Analytics: Methods, Models, and Decisions.	Evans, J.R.	Pearson Education	3/e, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Business analytics: Data analysis & decision making.	Albright, S. Christian, and Wayne L. Winston	Cengage Learning	1/e, 2014
2	Web Analytics Demystified: A Marketer's Guide to Understanding How Your Website Affects Your Business	Peterson	Celilo Group Media & Café Press	1/e, 2014
3	Business Analytics: The art of Modeling with Spreadsheets	Stephen G. Powell, Kenneth R. Baker	John Wiley & Sons	1/e, 2014

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLyqSpQzTE6M_68YmFFmjAAvTMne3xq9jf&si=enEJVg3z9mFf0LTy

SEMESTER S5

INFORMATION SYSTEMS

Course Code	**24SJPEADT523**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Elective

Course Objectives:

1. To provide students with a thorough understanding of the role and impact of information systems in organizations and society.
2. To develop students' ability to critically analyze and apply information security principles and ethical considerations in the management and implementation of information systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Information Systems: -** Introduction to Information Systems- Overview of Computer-Based Information Systems, Importance of Information Systems to Society, Business Processes- Business Process Reengineering, Business Process Improvement, and Business Process Management- Business Pressures, Organizational Responses, and Information Technology Support- Competitive Advantage and Strategic Information Systems- Ethics and Privacy	9
2	**Information Security and Controls: -** Information Security and Controls- Introduction to Information Security- Unintentional Threats to Information Systems - Deliberate Threats to Information Systems - What Organizations Are Doing to Protect -Information Resources - Information Security Controls - Personal Information Asset Protection	9

3	**Information Systems within the Organization: -** Information Systems within the Organization- Introduction- Transaction Processing Systems - Functional Area Information Systems- Enterprise Resource Planning Systems- ERP Support for Business Processes- Customer Relationship Management and Supply Chain Management	**9**
4	**Acquiring Information Systems and Applications: -** Acquiring Information Systems and Applications - Introduction -Planning for and Justifying IT Applications - Strategies for Acquiring IT Applications -Traditional Systems Development Life Cycle - Alternative Methods and Tools for Systems Development.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the Role and Impact of Information Systems in Organizations and Society	**K2**
CO2	Apply Knowledge of Information Security to Protect Organizational and Personal Assets and describe data and knowledge management principles and their importance in business decision-making	**K3**
CO3	Integrate and Manage Information Systems to Improve Organizational Efficiency.	**K3**
CO4	Implement Information Systems Using Appropriate Development and Acquisition Strategies	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2						2		1
CO2	3	2	2						2		2
CO3	2	2	2						2		2
CO4	3	3	3						2		2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to information systems: supporting and transforming business	Rainer, R. Kelly, Brad Prince	Wiley	2/e, 2001

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Management Information System	C. Laudon Kenneth P. Laudon Jane	Pearson	15/e. 2018
2	E-Business and E-Commerce Management: Strategy, Implementation and Practice	Dave Chaffey	Pearson	5/e, 2013
3	Business Process Change	Paul Harmon	Elsevier	4/e, 2019

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PL4719F414C9FBD659&si=nH6mpAZenDNEWQQs

SEMESTER S5

DATA COMPRESSION

Course Code	**24SJPECST524**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce students to basic applications, concepts, and techniques of Data Compression.
2. To develop skills for using recent data compression software to solve practical problems in a variety of disciplines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basic Compression Techniques: -** Data Compression Approaches - Variable-Length Codes, Run-Length Encoding, Space - Filling Curves, Dictionary-Based Methods, Transforms, Quantization. Huffman Encoding - Huffman Decoding, Adaptive Huffman Coding, Facsimile Compression. Run Length Encoding (RLE), RLE Text compression, Dictionary based Coding- LZ77, LZ78, LZW and Deflate: Zip and Gzip compression.	**10**
2	**Advanced Techniques: -** Arithmetic Coding - The Basic Idea, Implementation, Underflow; Image Compression- Introduction, Approaches to Image Compression, History of Gray Codes, Image Transforms, Orthogonal Transforms, The Discrete Cosine Transform, Intermezzo: Statistical Distributions, JPEG, Human Vision and Color, The Wavelet Transform, Filter Banks, WSQ, Fingerprint Compression	**10**
3	**Video Compression: -** Video Compression - Analog video, Digital Video, Motion Compensation. MPEG standards MPEG, H.261	**8**

4	**Audio Compression: -** Audio Compression - Companding, The Human Auditory System, Heinrich Georg Barkhausen, Linear Prediction, μ-Law and A-Law Companding, Shorten	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the fundamental approaches in data compression techniques and illustrate various classical data compression techniques	**K2**
CO2	Illustrate various text and image compression standards	**K3**
CO3	Describe the video compression mechanisms to reduce the redundancy in video	**K3**
CO4	Understand the fundamental principles of audio data compression	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								3
CO2	3	3	3								3
CO3	3	3	3								3
CO4	3	3									3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Concise Introduction to Data Compression	David Salomon	Springer	1/e, 2008
2	Data compression: The Complete Reference	David Salomon	Springer	3/e, 2004
3	Introduction to Data Compression	Khalid Sayood	Morgan Kaufman	1/e, 2003

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fractal and wavelet Image Compression techniques	Stephen Welstead,	PHI	1/e, 1999
2	Multimedia System	Sleinreitz	Springer	1/e, 2006
3	The Data Compression Book	Mark Nelson, Jean-loup Gailly	BPB Publications	1/e, 1996

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	An Introduction to Information Theory by Prof. Adrish Banerjee at IIT Kanpur https://youtube.com/playlist?list=PLZjlBaHNchvNzcqtxMAOCpnZ6NIsU6NIF&si=Xz4f2wXoa1M1ONbN

SEMESTER S5

COMPUTATIONAL BIOLOGY

Course Code	**24SJPEADT526**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Develop exposure in Computational Tools and Techniques for Biological Data Analysis
2. To equip students with hands-on experience in applying computational tools and software to biological problems and to familiarize them to current research trends in computational biology.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to biomolecules, DNA, RNA, and Protein: The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, translation, introduction to structure of prokaryotic and eukaryote gene	**9**
2	Introduction to Biological Databases: NCBI, Genbank, Bio sequence formats: FASTA, Sequence alignment: Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Gap Penalties, Amino Acid Scoring Matrices: PAM and BLOSUM, Database Similarity Searching, BLAST, Needleman and Wunsch and Smith–Waterman Method, Multiple Sequence Alignment, scoring function, Clustal.	**10**
3	Transcriptional Regulatory Networks, Genes and DNA Regulatory Regions, Genetic Interaction Map, Protein Interaction Networks, Experimental methodologies to obtain Protein Interaction Data, Computational methods to Predict Protein: Protein Interactions, Visualization of Protein Interaction Networks, Metabolic Networks, Interacting Partners, Mathematical Representation.	**10**

4	Next-Generation Sequencing (NGS) Technologies, Illumina Reversible Dye-Terminator Sequencing, Ion Torrent Semiconductor Sequencing, Pacific Biosciences Single Molecule Real-Time (SMRT) Sequencing, RNA-sequencing (RNA Seq), Protein-DNA Interaction Analysis (ChIP-Seq), Base Calling, FASTQ File Format, and Base Quality Score, NGS Data Quality Control and Preprocessing, Reads Mapping, Mapping Approaches and Algorithms	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate the structure and function of DNA, RNA proteins, Gene structure and process of transfer of information from DNA to protein	**K2**
CO2	Identify biological data formats and databases and employ similarity searching tools and algorithms to align sequences to highlight the similarity	**K3**
CO3	Demonstrate Networks in Biology, types of networks and its representation	**K3**
CO4	Explain Next Generation sequencing Technologies and DNA Protein interaction analysis and apply computational tools and algorithms to analyze NGS data.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								3
CO2	3	3	3								3
CO3	3	3	3								3
CO4	3	3	3								3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Bioinformatics	Lesk, Arthur M	Oxford University Press	5/e. 2019
2	Bioinformatics and Computational Biology. A Primer for Biologists	Basant K. Tiwary	Springer Nature Singapore	1/e, 2022
3	Bioinformatics. An Introduction	Jeremy Ramsden	Springer London	1/e,2016
4	An Introduction to Bioinformatics Algorithms	Neil C. Jones, Pavel Pevzner	MIT Press	1/e, 2004
5	Next-Generation Sequencing Data Analysis	Wang, Xinkun	CRC Press	1/e, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Bioinformatics and Computational Biology: A Primer for Biologists	Tiwary, Basant K	Springer	1/e, 2022
2	Quickstart Molecular Biology: An Introductory Course for Mathematicians, Physicists, and Computational Scientists	Benfey, Philip N.	Cold Spring Harbor Laboratory Press	1/e. 2014
3	Bioinformatics	Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart	John Wiley & Sons	4/e, 2020
4	Essentials of Bioinformatics	Shaik, Noor Ahmad, et al	Springer	1/e, 2019
5	Applied bioinformatics	Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer	Springer, Verlag	1/e, 2008
6	Bioinformatics: Methods and Applications	S C Rastogi, N Mendiratta and P Rastogi	PHI Learning Private Limited	4/e, 2013
7	Fundamental Concepts of Bioinformatics	D E Krane and M L Raymer	Pearson Education	1/e. 2006
8	Bioinformatics: Sequence and Genome Analysis	Bradley E. Shapiro and Jennifer J. Dudock	Garland Science	1/e, 2007

Video Links (NPTEL, SWAYAM…)	
Sl. No.	
1	https://youtube.com/playlist?list=PLyqSpQzTE6M88xI8FIcKarSBN2yPqMKbd&si=loFcUkhDt9ihMbHZ

SEMESTER S5

COMPUTER GRAPHICS & MULTIMEDIA

Course Code	**24SJPECST527**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To provide strong technological concepts in computer graphics including the three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build applications.
2. To give a good understanding of the multimedia frameworks for audio/video domains and different compression algorithms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basics of Computer graphics -** Basics of Computer Graphics and its applications. Video Display devices - LED, OLED, LCD, PDP and FED and reflective displays. Random and Raster scan displays and systems. **Line and Circle drawing Algorithms -** Line drawing algorithms- Bresenham's algorithm, Liang-Barsky Algorithm, Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's Circle drawing algorithm.	**10**
2	**Geometric transformations -** 2D and 3D basic transformations - Translation, Rotation, Scaling, Reflection and Shearing, Matrix representations and homogeneous coordinates. **Filled Area Primitives -** Scan line polygon filling, Boundary filling and flood filling.	**8**
3	**Transformations and Clipping Algorithms -** Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping	**8**

	algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms. **Three-dimensional graphics** - Three-dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm.	
4	**Fundamental of Multimedia** - Introduction to Multimedia, Authoring and Tools, Graphics and Image Data Representations, Popular File Formats, Fundamental Concepts and types of Video, Basics of Digital Audio and its types. **Compression Methods** - Lossless Compression Algorithms- Run-Length Coding, Arithmetic Coding. Lossy Compression Algorithms- Transform Coding. JPEG and JPEG-LS Standard Image Compression, H.261. Video Compression Technique.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles of computer graphics and displays and illustrate line drawing, circle drawing and polygon filling algorithms	**K2**
CO2	Illustrate 2D and 3D basic transformations and matrix representation	**K3**
CO3	Demonstrate different clipping algorithms and 3D viewing pipeline.	**K3**
CO4	Summarize the multimedia features and specific compression algorithms.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								3
CO2	3	3	3	3							3
CO3	3	3	3	3							3
CO4	3	3	3								3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Graphics: Algorithms and Implementations	D. P. Mukherjee, Debasish Jana	PHI	1/e, 2010
2	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4/e, 2013
3	Fundamentals of Multimedia	Ze-Nian Li and Mark S. Drew	Pearson	2003

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Flat Panel Displays	Jiun-Haw Lee, I-Chun Cheng, Hong Hua, Shin- Tson Wu	Wiley	1/e, 2020
2	Computer Graphics and Multimedia	ITL ESL	Pearson	1/e, 2013
3	Computer Graphics	Zhigang Xiang and Roy Plastock	McGraw Hill	2/e, 2000
4	Principles of Interactive Computer Graphics	William M. Newman and Robert F. Sproull	McGraw Hill	1/e, 2001
5	Procedural Elements for Computer Graphics	David F. Rogers	McGraw Hill	1/e, 2017
6	Computer Graphics	Donald D Hearn, M Pauline Baker	Pearson	2/e, 2002

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1, 2, 3	Computer Graphics by Prof. Samit Bhattacharya at IIT Guwahati https://youtube.com/playlist?list=PL_-TXQuxcwl85Vyg3GTo7SeXCK0jUXFmj&si=T4GLl0z3-FN8Jr9u
4	Web Based Technologies and Multimedia Applications by Prof. P. V. Suresh at Indira Gandhi National Open University https://youtu.be/mqFpkkqWfOM

SEMESTER S5

ADVANCED COMPUTER ARCHITECTURE

Course Code	**24SJPECST528**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the advanced processor architectures including parallelism concepts in Programming of multiprocessor and multi computers.
2. To provide detailed understanding about data flow in computer architectures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction – The impact of hardware and software technology trends Self review – Instruction set Architecture, Memory addressing, addressing modes Class of Computers, Concept of Computer Hardware and Organization (P15, 5th Edition) Measuring, Reporting and Summarizing Performance, Benchmarks – Desktop and Server Amdahl's Law, Processor Performance Equation *Beyond the books* – Visit www.spec.org. Explore the High Performance Computing benchmarks and compare the results submitted by different vendors for the same benchmark. Are you able to appreciate the need for benchmarks to compare performance? What are retired benchmarks? Can you write a paper and publish results based on a retired benchmark?	9
2	Review the basic Concepts of Parallel Processing and Pipelining Instruction Level Parallelism, data dependencies and hazards Different types of dependences, Compiler Techniques for ILP, Branch Prediction – Correlating	9

	branch predictor Dynamic Scheduling – Idea, Introduction to Tomasulo's scheme. Register Renaming Hardware Speculation, Reorder Buffers Multiple issue and static scheduling, VLIW	
3	Data Level Parallelism. Vector Processors – How do they work, Memory Banks, Stride, Scatter Gather. SIMD-comparison with vector GPU, Comparison of loops in C vs CUDA NVIDIA GPU Memory structure Vector Processor vs GPU, Multimedia SIMD computers vs GPU Multiprocessor Architecture, Centralized shared memory architecture Cache coherence and snooping protocol (Implementation details – not required). Performance of Symmetric Shared-Memory Processors. Distributed Shared Memory and Directory based protocol – basics. Synchronization – Basic Hardware Primtives. Memory Consistency Models – Sequential and relaxed	9
4	Warehouse Scale Computers – Goals and requirements. Programming frameworks for Batch processing – Map reduce and Hadoop Computer Architecture of Warehouse-scale computers Moore's Law, Dennard Scaling, Dark Silicon and the transition towards Heterogeneous Architectures Asymmetric multi-core architecture – Static and Dynamic (Overall idea, example processors) Functional Heterogeneous Multicore architecture – GPUs, Accelerators, Reconfigurable Computing Beyond the textbook – Identify the processor used in your PC and mobile phone. Study about its architecture, is it homogeneous or heterogeneous, does it use GPUs, what information can you gather about it from the manufacturer's website – Discuss in the class	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Enumerate the different classes of computers and where they are used in everyday life, compute the effect of hardware/software enhancements on the speedup of a processor using Amdahl's law and interpret possible dependencies that can cause hazards in a given block of code.	**K2**
CO2	Summarize different strategies followed to ensure Instruction Level Parallelism.	**K2**
CO3	Compare different strategies followed to ensure Instruction Level Parallelism and different strategies followed to ensure Data Parallelism.	**K3**
CO4	Illustrate the need for memory consistency models and cache coherence protocols and explain the principle behind it.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								3
CO2	3	3	3	3							3
CO3	3	3	3	3							3
CO4	3	3	3	3							3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer architecture: A Quantitative Approach.	Hennessy, J. and Patterson, D	Morgan Kaufman	5/e, 2012
2	The Dark Side of Silicon: Energy Efficient Computing in the Dark Silicon Era	Kanduri, Anil, et al.	Springer	1/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Architecture	Gérard Blanchet Bertrand Dupouy	Wiley	1/e, 2013
2	Advanced Computer Architectures	Sajjan C Shiva	Taylor & Fancis	1/e, 2018
3	Computer Architecture	Charles Fox	no starch press	1/e, 2024

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLwdnzlV3ogoWJhBxBYu-K4l-q-nNHd24D&si=ThwuWpkoqDfOpUHN

SEMESTER S5

FUNDAMENTALS OF DIGITAL IMAGE PROCESSING

Course Code	**24SJPEADT525**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2Hr. 30 Mins.
Prerequisites (if any)	None		

Course Objectives:

1. To provide foundational concepts of digital image representation, processing, and analysis, including image digitization, color theory, and various data structures, to effectively manipulate and analyze digital images.
2. To help the learner develop the ability to implement advanced image processing techniques, such as image segmentation, edge detection, and image compression, while critically evaluating the performance and quality of these methods in practical applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	The image, its representation and properties - Image representations, Image digitization, Sampling, Quantization, Digital image properties, Metric and topological properties of digital images, Histograms, Entropy, Visual perception of the image - contrast, acuity, Image quality, Noise in images; Color images - Physics of color, Color perceived by humans, Color spaces, Color constancy; Data structures for image analysis - Levels of image data representation, Traditional image data structures - matrices, Chains, Topological data structures - Relational structures, Hierarchical Data Structures, Pyramids, Quadtrees, Other pyramidal structures.	**9**
2	Image pre-processing - Pixel brightness transformations-, Position-dependent brightness correction, Gray-scale transformation, Geometric Transformations - Pixel coordinate transformations, Brightness interpolation. Local pre-processing, Image Smoothing, Edge detectors, Zero-crossings the second derivative, Scale in Image Processing, Canny Edge Detection, Parametric Edge Models, Edges Multi-spectral images, Line detection by	**9**

	local pre-processing operators, Detection of corners (interest points). Image Restoration - Degradations that are easy to restore, Inverse Filtering, Wiener Filtering.	
3	Image Segmentation - Thresholding, Threshold Detection Methods- Optimal thresholding, Multi-spectral thresholding, Edge-based segmentation, Edge Image Thresholding, Edge Relaxation, Border Tracing, Border Detection As Graph Searching, Border Detection As Dynamic Programming, Hough Transforms, Border Detection Using Border location information, Region construction from borders, Region-based segmentation - Region merging, Region Splitting - Splitting and Merging, Watershed segmentation. Mean shift segmentation, Fuzzy connectivity, Introduction to 3D graph-based image segmentation Matching, Template Matching, Control Strategies Templating, Evaluation Issues in Segmentation.	**9**
4	Image Transforms - 2D Fourier transform, Discrete Cosine Transform, Wavelet transform, Eigen-analysis, Singular value decomposition, Principal component analysis. Image texture - Statistical texture description, Methods Based on Spatial frequencies, Co-occurrence matrices, Edge Frequency, Primitive Length(runlength), texture energy measures, Local Binary Patterns LBPs, Fractal texture description, Other Statistical Methods of Texture Description. Introduction to Object recognition - Knowledge representation, Statistical pattern recognition, Classification principles, Minimum distance classifier learning and classification. Nearest neighbor search with K-D trees.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyse	Total
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

1. Understanding of Core Concepts (20%)

- Fundamentals: Grasp of basic image processing concepts such as pixel operations, color models, and image transformations.
- Algorithms: Knowledge of common image processing algorithms like filtering, edge detection, and image segmentation.
- Mathematics: Proficiency in the mathematical principles underlying image processing techniques, such as linear algebra and calculus.

2. Application of Techniques (25%)

- Practical Skills: Ability to implement and apply image processing techniques using software tools or programming languages (e.g., MATLAB, Python with libraries like OpenCV).
- Problem Solving: Capability to choose appropriate algorithms for specific image processing tasks and troubleshoot issues effectively.

3. Analysis and Interpretation (25%)

- Evaluation: Skill in analyzing the results of image processing operations and evaluating their effectiveness.
- Comparative Analysis: Ability to compare and contrast different methods or algorithms and justify the choice of one over another.

4. . Project and Case Study Work (30%)

- Project Execution: Ability to complete a project involving image processing from start to finish, including defining objectives, implementing solutions, and presenting findings.
- Case Study Analysis: Skill in analyzing real-world case studies or datasets to apply theoretical knowledge and solve practical problems.

Sample problems for assessment

1. Develop a program that reads an input image and manipulates its resolution in the spatial and gray domains; for a range of images (synthetic, of man-made objects, of natural scenes.) conduct experiments and make an assessment on the minimum resolution that leaves the image recognizable.
2. Write a program that computes an image histogram; plot the histogram of a range of images. Also acquire an RGB image and develop a program to obtain the YIQ and HSI representations. Also plot the histogram of the three components of a color image when represented as (a) RGB (b) YIQ (c) HSI
3. Develop programs for spatial domain image preprocessing techniques and provide a quantitative analysis of the effectiveness of different methods.
4. Develop a program for training and classification using the minimum distance classifier. Assess classification correctness. (a) Train and test using data sets TRAIN1 and TEST1. (b) Train and test using data sets TRAIN2 and TEST2.
5. Using the World Wide Web, find several images of dissimilar homogeneous textures (Brodatz textures [Brodatz, 1966] from a Web-based database may be a good choice)

   1. Create your personal database TD1 from these images of at least 5 texture type ranging gradually from fine to coarse.

   2. Create a texture database TD2 of three dissimilar texture classes with at least ten images belonging to each class.

   3. Create a database TD3 of at least three homogeneous directional textures (use preferably several images from each class) and rotate each at 9 random angles this will form a database of 10 directional images for each texture.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyse the properties of monochrome/colour images along with the effect of different types of noise in images.	K4
CO2	Apply different preprocessing techniques to visualize image enhancement	K3
CO3	Understand and evaluate the different methods of image segmentation techniques.	K5
CO4	Analyse and evaluate the various transforms and the different image compression techniques used in image processing and create a feature database for an object recognition problem.	K5

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	**3**	**3**	**3**								**2**
CO2	**3**	**3**	**3**	**3**							**2**
CO3	**3**	**3**	**3**	**3**							**2**
CO4	**3**	**3**	**3**	**3**							**2**

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Image Processing, Analysis and Machine Vision	Milan Sonka, Vaclav Hlavac, Roger Boyle	Cengage	4/e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamental of Digital Image Processing	Anil K. Jain	Pearson	1/e, 2015
2	Digital image Processing	Ralph Gonzalez, Richard Woods	Pearson	4/e, 2018
3	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	McGraw Hill	2/e, 2020
4	Fundamental of Digital Image Processing	Anil K. Jain	Pearson	1/e, 2015

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLuv3GM6-gsE08DuaC6pFUvFaDZ7EnWGX8&si=kPWnQQx9GeqfHJK9

SEMESTER – VI

SIXTH SEMESTER (July-December)														
Sl. No:	Slot	Course Code	Course	Course	Course Title (Course Name)	Credit Structure				SS	Total Marks		Credits	Hrs./ Week
						L	T	P	R		CIE	ESE		
1	A	24SJPCADT601	PC	PC	Deep Learning	3	1	0	0	5	40	60	4	4
2	B	24SJPCADT602	PC	PC	Internet of Things	3	0	0	0	4.5	40	60	3	3
3	C	24SJPEADT63N	PE	PE	PE-3	3	0	0	0	4.5	40	60	3	3
4	D	24SJPBADT604	PC-PBL	PB	Data Mining and Warehousing	3	0	0	1	5.5	60	40	4	4
5	F	24SJGAEST605	ESC	GC	Design Thinking and Product Development	2	0	0	0	3	40	60	2	2
6	O#	24SJOEADT61N / 24SJIEADT61N	OE / ILE	OE/IE	OE/ILE-1	3	0	0	0	4.5	40	60	3	3
7	L	24SJPCADL607	PCL	PC	Deep Learning Lab	0	0	3	0	1.5	50	50	2	3
8	P	24SJPCADP608	PWS	PC	Mini Project: Socially Relevant Project	0	0	0	3	3	50	50	2	3
9	R/ M/ H		VAC		Remedial/Minor/Honours Course	3	0	0	0	4.5			3*	3*
	S5/ S6	Industrial Visit (Maximum of 6 Days are permitted, Not Exceeding more than 4 Working Days) /Industrial Training												
Total										**32/ 36**			**23/26***	**25/28***

 # Open elective/Industry linked elective applicable to AD Students

Note: Open Electives are such courses which will be offered by other departments. Like AD department students have to opt open electives from ECE/ME/EEE etc. departments.
***Industrial Training:** Students who are not participating in the industrial visit must attend industrial training during that period.*

SEMESTER S6

DEEP LEARNING

Course Code	**24SJPCADT601**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCCST503	**Course Type**	Theory

Course Objectives:

1. To get an insight into various design parameters of a deep learning model.
2. To introduce deep learning architectures for various domains such as text, multimedia and GenAI tools.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Deep learning**: Introduction, Deep feed forward network. Activation functions – ReLU, leaky ReLU, Hard Tanh, Softmax. Loss function. Training a Neural Network with Backpropagation. Practical issues in neural network training. Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance.	**10**
2	**Network Design parameters:** Introduction, setup and initialization Kaiming, Xavier weight initialization, Vanishing and exploding gradient problems, Optimization techniques - Gradient Descent (GD), Stochastic GD- GD with momentum- GD with Nesterov momentum; Parameter specific learning rates: AdaGrad- RMSProp- Adam; Regularization Techniques - L1 and L2 regularization- Early stopping. Dataset augmentation- Parameter tying and sharing- Ensemble methods- Dropout- Batch normalization.	**12**
3	Convolutional Neural Network: Basic structure of a CNN; Basic layers and operations in CNN: Convolution operation- effect of stride and padding- Fully Connected layers- CNN layers; Building a CNN model: Training a CNN; Estimation of Tensor size number of features in CNN layers, Transfer	**11**

	learning (size similarity matrix)-Pre-trained architectures- AlexNet, ResNet-50, GoogleNet.	
4	**Deep learning models for text processing:** Recurrent Neural Network architecture; Variants of RNN architectures: Deep Recurrent Neural Network- Recursive Neural Network- Bidirectional recurrent neural network, Encoder-Decoder architecture, LSTM, GRU. **Auto Encoders and Generative models**. Autoencoders- Variational Autoencoder-under complete Autoencoder, stochastic encoder, denoising encoder; Applications of Autoencoders. Generative models - Boltzmann machines- Deep Belief Networks- Generative Adversarial Networks	**11**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Outline the standard regularization and optimization techniques for the effective training of deep neural networks	**K2**
CO2	Use Convolutional Neural Network (CNN) models and pretrained networks for different use cases.	**K3**
CO3	Apply the concepts of Recurrent Neural Network, its variants and familiarize natural language processing fundamentals.	**K3**
CO4	Apply the concepts of auto encoder, generative models for advanced AI operations and apply the concept of generative models for advanced AI operations	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3							3
CO2	3	3	3	3	3						3
CO3	3	3	3	3	3						3
CO4	3	3	3	3	2						3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning	Goodfellow, I., Bengio,Y., and Courville, A.	MIT Press	1/e, 2016
2	Neural Networks and Deep Learning	Aggarwal, Charu C	Springer International	1/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning, Core Concepts, Methods and Applications	M Gopal	Pearson Education	1/e, 2022
2	Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithm	Nikhil Buduma and Nicholas Locascio	O'Reilly Media	1/e, 2017

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLyqSpQzTE6M9gCgajvQbc68Hk_JKGBAYT&si=hharoYT96J2KQDQi

SEMESTER S6

INTERNET OF THINGS

Course Code	24SJPCADT602	CIE Marks	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the fundamentals of IoT architecture, including its origins, impact, and the convergence with IT.
2. To explore the components of IoT networks such as smart objects, sensors, actuators, and communication technologies, with a focus on IP optimization and application protocols.
3. To learn about data analytics for IoT, covering machine learning, big data tools, and methods for securing IoT systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**IoT Architecture -** What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.	8
2	**Engineering IoT Networks -** Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. IoT Network Layer: IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT,	14
3	**IoT protocols -** Application Protocols for IoT (XMPP, MQTT, CoAP, SOAP, HTTP only), Transport Layer, IoT Application Transport Methods.	12

	Data Analytics for IoT: Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology.	
4	**Developing IoT Systems -** IoT Logical Design using Python, IoT Physical Devices and Endpoints - Raspberry Pi interfaces, Programming Raspberry Pi using Python, WAMP. Developing Tools: Arduino, Apache NetBeans, Kinoma, IBM Watson IoT, Node-RED Case study: IoT in Agriculture, IoT in Smart city.	**10**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of IoT architecture, including its genesis and impact	**K2**
CO2	Learn to engineer IoT networks with smart objects, sensors, and actuators.	**K2**
CO3	Become familiar with IoT protocols such as XMPP, MQTT, CoAP, SOAP, and HTTP and develop skills in data analytics for IoT, using machine learning and big data tools.	**K2**
CO4	Gain practical experience in developing IoT systems using Python, Raspberry Pi, and Arduino.	**K3**

Note: *K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3										
CO2	3	3			3						
CO3	3										
CO4	3		3		3		3	3	3	3	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	IoT Fundamentals Networking Technologies, Protocols, and use cases for the Internet of Things	David Hames, Gonzalo Salguerio, Patrick Grossetete, Robert Barton, Jerome Henry	Pearson Education	1/e, 2016
2	Internet of Things: A hands-on approach	Arshadeep Bahga, Vijay Madisetti	University Press	1/e, 2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of Things: Architecture and Design Principles	Rajkamal	McGraw Hill	1/e,2017
2	Architecting the Internet of Things	Dieter Uckelmann, Mark Harrison, Florian Michahelles	Springer Science & Business Media,	1/e, 2011
3	Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems	Dr. Ovidiu Vermesan, Dr. Peter Friess,	River Publishers	1/e, 2013
4	Programming Arduino: Getting Started with Sketches	Simon Monk	McGraw Hill	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLJ5C_6qdAvBG7SHg5mLOQq6bzF-sOPu3k&si=tTGnaQQ5wzLDCoPg

SEMESTER 6

DATA MINING AND WAREHOUSING

Course Code	**24SJPBADT604**	**CIE Marks**	60
Teaching Hours/Week (L: T: P: R)	4	**ESE Marks**	40
Credits	3:0:0:1	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPBADT304	**Course Type**	Theory

Course Objectives:

1. To understand the principles of Data warehousing and Data Mining.
2. To be familiar with the Data warehouse architecture and its Implementation
3. To perform classification, association, and prediction of data

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Data Mining:** Introduction, What is Data Mining, Definition, KDD, Challenges, Data Mining life cycle, Data Pre-processing concepts **Association Rule Mining**: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.	**10**
2	**Cluster Analysis**: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.	**11**
3	**Classification and Prediction**: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.	**15**

4	**Introduction to Data Warehousing**. - Evolution of Decision Support Systems- Data warehousing Components –Building a Data warehouse, Data Warehouse and DBMS, Data marts, Metadata, Multidimensional data model, OLAP v s OLTP, OLAP operations, Data cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations.	**10**

Suggestion on Project Topics

Students can implement various data related projects, from any domain, using the techniques studied in the syllabus. It may contain sections for data storage, data pre-processing and small levels of data mining to recognize patterns in the data. Socially relevant project domains are highly appreciated. Check the datasets available at https://www.kaggle.com/datasets/ and perform data pre-processing operations such as data cleaning, missing value management and mine useful information from the dataset.

A suggestive list of projects are added here. Similar projects could be added by concerned faculty:

1. Perform association technique on customer data set/ agriculture data set
2. Create the data warehouse for any medical shop having 2 or more branches
3. Predict traffic conditions for allocating more buses on various routes by bus controller
3. Predict Job opportunities Computer/IT field looking into the work generated last year.

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	**30**	**12.5**	**12.5**	**60**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 subdivisions. • Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Comprehend the key process of data mining and analyse the kinds of patterns that can be discovered by association rule mining	**K3**
CO2	Implement various clustering methods	**K3**
CO3	Identify interesting patterns from large amounts of data for predictions and classification.	**K3**
CO4	Understand warehousing architectures for organizing large database and use tools for systematically organizing large databases and use their data to make strategic decisions.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3		3						3
CO2	3	3	3		3						3
CO3	3	3	3		3						3
CO4	3	3	3		3						3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data mining Concepts and Techniques	Jiawei Han, Michelin Kamber, Jian Pei	Elsevier	3/e, 2011
2	Data Mining: Introductory and Advanced Topics	Margaret H Dunham	Pearson Education	1/e,2006
3	Data Warehousing, Data Mining & OLAP	Alex Berson and Stephen J. Smith	Mc Graw Hill	1/e, 2008.
4	Introduction to Data Mining,	Pang-Ning Tan, Michael Steinbach and Vipin Kumar	Pearson Education	1/e, 2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Insight into Data mining Theory and Practice	K.P. Soman, Shyam Diwakar, V. Ajay	Prentice Hall of India	1/e2006.
2	Data Mining Techniques	Arun K. Pujari	Universities Press	4/e, 2016
3	Introduction to Data Min Data Mining with Case Studies	G. K. Gupta	Prentice Hall of India	3/e, 2014

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLLspfyoOYoQcI6Nno3gPkq0h5YSe81hsc&si=Mn6qtgfliUM2zVnD

PBL Course Elements

L: Lecture (3 Hrs.)	**R: Project (1 Hr.), 2 Faculty Members**		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Projectreformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

1. **Project Planning and Proposal (5 Marks)**

   - Clarity and feasibility of the project plan
   - Research and background understanding
   - Defined objectives and methodology

2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**

   - Individual contribution to the presentation
   - Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**

   - Active participation and individual contribution
   - Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**

   - Adherence to the project timeline and milestones
   - Application of theoretical knowledge and problem-solving
   - Final Result

5. **Final Presentation (5 Marks)**

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER S6

DESIGN THINKING AND PRODUCT DEVELOPMENT

Course Code	**24SJGAEST605**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	2:0:0:0	**ESE Marks**	60
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To guide students through the iterative stages of design thinking, including empathizing with users, defining problems, ideating solutions and developing Proof of Concepts (PoC) and technical feasibility studies.
2. To promote the development of critical thinking skills by engaging students in integrative inquiry, where they ask meaningful questions that connect classroom knowledge with real-world applications.
3. To equip students with the ability to involve in product design considering the sustainability, inclusivity, diversity and equity aspects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of design thinking and product development:** Overview of stages of product development lifecycle; Design thinking -Definition-Design thinking for product innovation; Bringing social impact in ideation-Identifying societal needs-understanding multi-faceted issues-community engagement and empathetic design- technological innovation meeting societal needs; Understanding and Bridging the divide using Human Centered Design (HCD); Designing for inclusivity in product development-embracing user diversity - Long term impact - sustainability encompassing environmental, economic and social dimensions; Technology Readiness Level in the Innovation Life-cycle; Performing a self-check on innovative ideas - Originality of idea-	**6**

	understanding innovation landscape - patentability - understanding the economic landscape - Unique Selling Proposition (USP) - Repeatability and Manufacturability - Sustainability - Leveraging business models for comprehensive analysis	
2	**Empathize:** Design thinking phases; Role of empathy in design thinking; Methods of empathize phase - Ask 5 Why/ 5 W+H questions; Empathy maps - Things to be done prior to empathy mapping - Activities during and after the session; Understanding empathy tools - Customer Journey Map - Personas. **Define**: Methods of Define Phase: Storytelling, Critical items diagrams, Define success.	**6**
3	**Ideation** : Stages of ideation; Techniques and tools - Divergent thinking tools - Convergent thinking tools - Idea capturing tools; Cross-industry inspiration; Role of research in ideation - Market research - consumer research - leveraging research for informed ideation; Technological trends - navigating the technological landscape - Integrating emerging technologies; Feasibility studies - technical, economic, market, operational, legal, and ethical feasibility; Ideation session- techniques and tips. **Proof of Concept (PoC):** Setting objectives; Risk assessment; Technology scouting; Document and process management; Change management; Knowledge Capture; Validating PoC; Story telling in PoC presentation	**6**
4	**Design:** Navigating from PoC to detailed design; Developing Specification Requirement Document (SRD)/Software Requirement Specification (SRS); Design for manufacturability; Industrial standards and readability of code; Design to cost; Pre-compliance; Optimized code; Design Failure Mode and Effects Analysis (DFMEA); Forecasting future design changes. **Prototyping:** Alpha prototypes; Beta prototypes; Transition from design to prototype; Goals and expectations for Alpha and Beta prototypes; Effective strategies for maintaining timeline in prototyping; Testing and refining Alpha prototypes; Transitioning to Beta prototypes. **Pilot build:** Definition and purpose of a pilot build; setting objectives; Identification and selection of manufacturing partner for pilot build; Testing procedures in pilot build; Scaling from pilot build to full-scale production / implementation.	**6**

	Experiential Innovation Platforms: Hackathons and Ideathons - Definition, Features, Types, Benefits, Key Differences Between Hackathons and Ideathons (Reference: https://medium.com/@zettabyte_pte_ltd/whats-the-difference-between-a-hackathon-and-an-ideathon-263c37335847)	

Course Assessment Method (CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignments	Internal Examination	Reflective Journal and Portfolio	Total
5	20	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Empathize to capture the user needs and define the objectives with due consideration of various aspects including inclusivity, diversity and equity	**K5**

CO2	Ideate using divergent and convergent thinking to arrive at innovative ideas keeping in mind the sustainability, inclusivity, diversity and equity aspects.	**K5**
CO3	Engage in Human Centric Design of innovative products meeting the specifications	**K5**
CO4	Develop Proof of Concepts (PoC), prototypes & pilot build of products and test their performance with respect to the Specification Requirement Document and reflect on professional and personal growth through the learnings in the course, identifying areas for further development	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	2	2		2	3	3	2	2		3
CO2	3	2	3		2	3	3	2	2		3
CO3	3	2	3		2	3	2	2	2		3
CO4	3	2	2		3	3	2	2	2		3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Product Sense: Engineering your ideas into reality	Dr. K R Suresh Nair	NotionPress.com	2024
2	Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation	Tim Brown	Harper Collins Publishers Ltd.	2009
3	Design Thinking for Strategic Innovation	Idris Mootee	John Wiley & Sons Inc.	2013

Sample Assignments:

1. Evaluate and prepare a report on how the aspects including inclusivity, diversity and equity are taken into consideration during the empathize and define phases of the Miniproject course.
2. Evaluate and prepare a report on how the aspects including sustainability, inclusivity, diversity and equity are taken into consideration during the ideate phase of the Miniproject course.
3. Evaluate and prepare a report on how User-Centric Design (UCD) is used in the design and development of PoC of the product being developed in the Miniproject course.
4. Prepare a plan for the prototype building of the product being developed in the Miniproject course.
5. Report on the activities during the empathize phase including the maps & other materials created during the sessions.
6. Report on the activities during the define phase including the maps & other materials created during the sessions.
7. Report of all the ideas created during the ideation phase of the Miniproject course through the tools including SCAMPER technique, SWOT analysis, Decision matrix analysis, six thinking hats exercise
8. Prepare a full scale production plan for the product being developed in the Miniproject course.
9. Create a Stanford Business Model Canvas related to the Miniproject.
10. An industrial visit of at least a day for experiential learning and submit a report on the learnings, for example industry standards and procedures.

SEMESTER S6

DEEP LEARNING LAB

Course Code	**24SJPCADL607**	**CIE Marks**	50
Teaching Hours/Week (L: T: P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCCST503, 24SJPCADT601	**Course Type**	Lab

Course Objectives:

1. To get hands-on experience in machine learning.
2. To develop deep learning models for computer vision and natural languages using python.

Note:

- *A minimum of ten experiments must be completed as part of the course requirements.*
- *Students are instructed to submit only the fair record for both Continuous Internal Evaluation (CIE) and End Semester Examinations (ESE). Rough records are not required.*

Expt. No.	Experiments
1	Implement and demonstrate Single, Multi variable and Polynomial Regression for a given set of training data stored in a .CSV file and evaluate the accuracy.
2	Implement a Python program to perform logistic regression on a dataset.
3	Write a Python program to implement Naive Bayes classifier and calculate the accuracy, precision, and recall for your data set.
4	Write a Python 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.
5	Assuming a set of data that need to be classified, use a Support Vector Machine classifier to perform this task and evaluate the accuracy.
6	Implement any Clustering algorithm on a given dataset to categorize the data.
7	Build an Artificial Neural Network using Backpropagation algorithm on a given dataset and test the same with appropriate dataset.

8	Implement Feed forward neural network with three hidden layers for classification on CIFAR-10 dataset. Analyse the impact of optimization and weight initialization techniques such as Xavier initialization, Kaiming Initialization, dropout and regularization techniques, and visualize the change in performance.
9	Digit classification using CNN architecture for MNIST dataset. Identify the performance change through pre-trained networks such as VGGNet or GoogleNet.
10	Implement a simple RNN for review classification using IMDB dataset. Analyze and visualize the performance change while using LSTM and GRU instead of simple RNN.
11	Implement time series forecasting prediction for NIFTY-50 dataset.
12	Implement a shallow auto encoder and decoder network for machine translation (by using any dataset in Kaggle such as English to Hindi neural translation dataset).

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop machine learning models in python for regression, classification and clustering tasks using algorithms such as naïve bayes, decision tree, ANN and SVM.	**K3**
CO2	Implement a deep learning model for computer vision tasks and increase the performance of the model through hyper parameter tuning.	**K4**
CO3	Develop a recurrent neural network for sequence modelling such as text or time series data and analyse the performance change through LSTM and GRU.	**K4**
CO4	Develop an algorithm for machine translation using python.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	2	2	2		1			2
CO2	1	1	1	1	2	2		1			2
CO3	1	1	2	2	2	2		1			2
CO4	1	1	2	2	2	2		1			2

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Hands–On Machine Learning with Scikit–Learn and TensorFlow	Aurelien Geron	O'Relily	3/e, 2022
2	Deep Learning with Python	François Chollet	Manning	2/e,2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	2/e,2010
2	Deep Learning	Goodfellow, I., Bengio,Y., and Courville, A.	MIT Press	1/e,2016

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLyqSpQzTE6M9gCgajvQbc68Hk_JKGBAYT&si=gu8iu7KVanZzh6Wp

Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**

   - Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
   - Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**

   - Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
   - Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
   - Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

   - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
   - Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

   - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

   - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.

- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S6

MINI PROJECT: Socially Relevant Project

Course Code	**24SJPCADP608**	**CIE Marks**	50
Teaching Hours/Week (L: T: P: R)	0:0:0:3	**ESE Marks**	50
Credits	2	**Exam Hours**	NA
Prerequisites (if any)	None	**Course Type**	Project

Preamble: The objective of this course is to apply the fundamental concepts of Engineering discipline principles for the effective development of an application/research project. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Course Assessment Method (CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	**Project Guide**	**Evaluation by the Committee** (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement)	**Project Report**	**Total**
5	**15**	**20**	**10**	**50**

End Semester Examination Marks (ESE)

Presentation	**Demonstration**	**Viva**	**Total**
20	**20**	**10**	**50**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify technically and economically feasible problems of social relevance	**K3**
CO2	Identify and survey the relevant literature for getting exposed to related solutions	**K3**
CO3	Perform requirement analysis and identify design methodologies and develop adaptable and reusable solutions of minimal complexity by using modern tools and advanced programming techniques	**K3**
CO4	Prepare technical report and deliver presentation	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3

Course Plan

Student Groups with 3 or 4 members should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted with the Head of the Department or a senior faculty, Mini Project coordinator and project guide as the members. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight. The internal evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The product/application has to be demonstrated for its full design specifications.

Guidelines for the Report preparation

A bonafide report on mini project shall be submitted within one week after the final presentation. Minimum number of pages should be 40.

- Use Times New Roman font for the entire Report – Chapter / Section Title –Times New Roman 18, Bold; Heading 2 – Times New Roman 16, Bold; Heading 3 – Times New Roman 14, Bold; Body- Times New Roman12, Normal.
- Line Spacing – Between Heading 2 – 3 lines, between lines in paragraph 1.5 lines.
- Alignments – Chapter / Section Title – Center, Heading 2 & 3 should be Left Aligned. Ensure that all body text is paragraph justified.
- Figures & Tables – Ensure that all Figures and Tables are suitably numbered and given proper names/headings. Write figure title under the figure and table title above the table
- Suggestive order of documentation:

  i. Top Cover

  ii. Title page

  iii. Certification page

  iv. Acknowledgement

  v. Abstract

  vi. Table of Contents

  vii. List of Figures and Tables

  viii. Chapters

  ix. Appendices, if any

  x. References/Bibliography

PROGRAM ELECTIVE – 3

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
C	24SJPECST631	Software Testing	3-0-0-0	3	3
	24SJPEADT632	Computational Linguistics	3-0-0-0		3
	24SJPEADT633	Machine Learning in Computational Biology	3-0-0-0		3
	24SJPECST634	Advanced Database Systems	3-0-0-0		3
	24SJPEADT636	Web Mining	3-0-0-0		3
	24SJPECST637	Fundamentals of Cryptography	3-0-0-0		3
	24SJPECST638	Quantum Computing	3-0-0-0		3
	24SJPEADT635	Natural Language Processing	3-0-0-0		**5/3**

SEMESTER S6

SOFTWARE TESTING

Course Code	**24SJPECST631**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To Cultivate proficiency in software testing methodologies and techniques.
2. To Foster expertise in software testing tools and technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Software Testing & Automation:-** Introduction to Software Testing - Concepts, importance of testing, software quality, and real-world failures (e.g., Ariane 5, Therac 25); Software Testing Processes - Levels of thinking in testing; Testing Terminologies - Verification, validation, fault, error, bug, test cases, and coverage criteria; Types of Testing - Unit, Integration, System, Acceptance, Performance (stress, usability, regression), and Security Testing; Industry Trends - AI in test case automation, Introduction to GenAI in testing; Testing Methods - Black-Box, White-Box, and Grey-Box Testing; Automation in Testing - Introduction to automation tools (e.g., Selenium, Cypress, JUnit); Case Study- Automation of Unit Testing and Mutation Testing using JUnit.	8
2	**Unit Testing, Mutation Testing & AI-Driven Automation:-** Unit Testing- Static and Dynamic Unit Testing, control flow testing, data flow testing, domain testing; Mutation Testing- Mutation operators, mutants, mutation score, and modern mutation testing tools (e.g., Muclipse); JUnit Framework - Automation of unit testing, frameworks for testing in real-world projects; AI in Testing - GenAI for test case	8

	generation and optimization, impact on automation; Industry Tools - Application of AI-driven testing tools in automation and predictive testing; Case Study - Mutation testing using JUnit, AI-enhanced test case automation.	
3	**Advanced White Box Testing & Security Testing:-** Graph Coverage Criteria - Node, edge, and path coverage; prime path and round trip coverage; Data Flow Criteria - du paths, du pairs, subsumption relationships; Graph Coverage for Code - Control flow graphs (CFGs) for complex structures (e.g., loops, exceptions); Graph Coverage for Design Elements - Call graphs, class inheritance testing, and coupling data-flow pairs; Security Testing - Fundamentals, tools (OWASP, Burp Suite), and their role in protecting modern applications; Case Study - Application of graph based testing and security testing using industry standard tools.	**10**
4	**Black Box Testing, Grey Box Testing, and Responsive Testing:-** Black Box Testing - Input space partitioning, domain testing, functional testing (equivalence class partitioning, boundary value analysis, decision tables, random testing); Grey Box Testing - Introduction, advantages, and methodologies (matrix testing, regression testing, orthogonal array testing); Performance Testing - Network latency testing, browser compatibility, responsive testing across multiple devices (e.g., BrowserStack, LambdaTest); Introduction to PEX - Symbolic execution, parameterized unit testing, symbolic execution trees, and their application; GenAI in Testing - Advanced use cases for predictive and responsive testing across devices and environments; Case Study- Implementation of black-box, grey-box, and responsive testing using PEX and AI-driven tools.	**10**

Course Assessment Method (CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate the ability to apply a range of software testing techniques, including unit testing using JUnit and automation tools.	**K2**
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	**K3**
CO3	Explain and apply graph coverage criteria in terms of control flow and data flow graphs to improve code quality and illustrate the importance of security, compatibility, and performance testing across devices.	**K3**
CO4	Demonstrate the importance of black-box approaches in terms of Domain and Functional Testing and use advanced tools like PEX to perform symbolic execution and optimize test case generation and also leverage AI tools for automated test case prediction and symbolic execution with PEX.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								3
CO2	3	3	3	3	3						3
CO3	3	3	3		3						3
CO4	3	3	3	3	3						3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Software Testing.	Paul Ammann, Jeff Offutt	Cambridge University Press	2/e, 2016
2	Software Testing and Quality Assurance: Theory and Practice	Kshirasagar Naik, Priyadarshi Tripathy	Wiley	1/e, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Software Testing	Ron Patten	Pearson	2/e, 2005
2	Software Testing: A Craftsman's Approach	Paul C. Jorgensen	CRC Press	4/e, 2017
3	Foundations of Software Testing	Dorothy Graham, Rex Black, Erik van Veenendaal	Cengage	4/e, 2021
4	The Art of Software Testing	Glenford J. Myers, Tom Badgett, Corey Sandler	Wiley	3/e, 2011

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLyqSpQzTE6M-sBjDcT21Gpnj8grR2fDgc&si=eyRFlCEGeT8Ovbg2

SEMESTER S6

COMPUTATIONAL LINGUISTICS

Course Code	**24SJPEADT632**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the core concepts and methodologies in computational linguistics.
2. To equip the practical skills in applying language processing tools, such as Python and NLTK.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Linguistic Essentials-** Parts of Speech and Morphology, Nouns and Pronouns, Words that Accompany Nouns: Determiners and Adjectives, Verbs, Other Parts of Speech, Phrase Structure, Phrase Structure Grammars, Semantics and Pragmatics, Corpus-Based Work, The Ambiguity of Language (NLP Challenges). **Mathematical Essentials-** Probability Theory, Probability Space, Conditional Probability and Independence, Bayes Theorem, Random Variables, Expectation and Variance, Notation, Joint and Conditional Distributions, Standard Distributions, Bayesian Statistics.	**12**
2	**Statistical Inference-** n-gram Models over Sparse Data, Bins: Forming Equivalence Classes, Reliability vs Discrimination, n-gram Models **Markov Models-** Hidden Markov Models, Use of HMMs, General Form of HMM, Probability of an Observation, Best State Sequence	**8**

3	**Word Sense Disambiguation-** Methodological Preliminaries, Supervised and unsupervised learning, Pseudowords, Upper and lower bounds on performance, Supervised Disambiguation, Bayesian classification-, Dictionary based Disambiguation, Disambiguation based on sense definitions, Thesaurus based disambiguation, Lexical Acquisition, Evaluation Measures, Verb subcategorization, Attachment Ambiguity, PP attachment, Selectional references, Semantic Similarity, Word2Vec and Doc2Vec	**10**
4	**Grammar and tools:** Part-of-Speech Tagging, The Information Sources in Tagging, Markov Model Taggers, Hidden Markov Model Taggers, Applying HMMs to POS Tagging, Probabilistic Context Free Grammars, Some Features of PCFGs, Questions for PCFGs, The Probability of a String, Using Inside Probabilities, Using Outside Probabilities, Finding the Most Likely Parse for a Sentence, Parsing for Disambiguation, Parsing Model versus Language Model, Language Processing with Python using NLTK	**10**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the fundamental linguistic concepts, including parts of speech, morphology, phrase structure, semantics, and pragmatics to analyze natural language data.	**K2**
CO2	Describe probabilistic and statistical models, such as n-gram models and Hidden Markov Models (HMMs), to process and predict linguistic patterns in sparse data.	**K2**
CO3	Demonstrate knowledge of word sense disambiguation techniques, including supervised and unsupervised learning methods and evaluate and employ lexical acquisition methods, such as verb subcategorization and semantic similarity measures	**K2**
CO4	Utilize computational tools and grammars, such as part-of-speech tagging, probabilistic context-free grammars (PCFGs), and Python NLTK, to develop and implement language processing applications.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3									
CO2	3	3			3						
CO3	3	3			3						
CO4	3	3			3			3	3	3	3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Foundations of Statistical Natural Language Processing	C.D. Manning H. Schutze	MIT Press	1/e, 1999
2	Natural Language Processing with Python and NLTK.	Steven Bird, Ewan Klein, Edward Loper	O'reilly Pub	1/e, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Speech and Language Processing: Introduction to Natural Language Processing Computational Linguistics and Speech Recognition, PHI	D. Jurafsky, J H Martin	Pearson	1/e, 2009
2	Natural Language Understanding	James Allen	Benjamin-Cummings	1/e, 1988
3	Natural Language Processing: Python and NLTK	Nithin Hardeniya, Jacob Perkins, Deepthi Chopra, Nisheeth Joshi, Iti Mathur	Packt Publishing	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLyqSpQzTE6M_EcNgdZ2qOtTZe7YI4Eedb&si=UY_EVM6VhGp-s9v6

SEMESTER S6

MACHINE LEARNING IN COMPUTATIONAL BIOLOGY

Course Code	**24SJPEADT633**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCCST503	**Course Type**	Theory

Course Objectives:

1. To familiarize students with a foundational understanding of computational biology, including its scope, significance and key challenges
2. To introduce the ethical considerations, limitations, and challenges in applying machine learning to biological data, including issues related to data privacy, biases in algorithms, and the reproducibility of results.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Role of Machine Learning in Computational Biology** Introduction - Creation and analysis of sequence data, Challenges of Machine Learning in Computational Biology. Future directions of Machine Learning in Computational Biology.	8
2	**Clustering problems Computational Biology** Hierarchical Clustering, Partition Clustering, Overview Model-Based Clustering, k-Means clustering, k-Means clustering algorithm, Advantages, Disadvantages, illustrative example of k- Means clustering, Clustering for creating phylogenetic trees, Using Clustering Approach to Identify Patients' Subtypes, Application of clustering algorithms on gene expression data	9

3	**Supervised techniques for Computational Biology** Proteomics Dataset, Data Preprocessing Algorithms, Dimension and Feature Subset Selection, Partial Least Square (PLS), Linear Discriminant Analysis (LDA), Protein Classification, Support Vector Machine with Feature Elimination. Data Errors, Mean Square Error Generative versus Discriminative, Approximation Versus Explanation, Single Versus Multiple Methods.	**10**
4	**Machine-Learning Algorithms for Computational Biology** Machine-Learning Algorithms for Feature Selection from Gene Expression Data, Feature Extraction and Pattern recognition from sequence data, measures of a Feature, Dimensionality reduction - Principal Component Analysis (PCA), Decision Trees in Bioinformatics. Artificial Neural Network (ANN) in Bioinformatics, Genetic Algorithms (GA) in Bioinformatics.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the basic concepts of Machine Leaning, Classification, regression and clustering problems, parameters and measures	**K2**
CO2	Demonstrate the clustering algorithm on computational biology problems	**K3**
CO3	Apply Dimensionality reduction techniques and Decision Trees in computational biology	**K3**
CO4	Illustrate Feature Extraction and Pattern recognition and Classification in the domain of Computational Biology analysis	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								3
CO2	3	3	3								3
CO3	3	3	3								3
CO4	3	3	3								3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications	K. G. Srinivasa, G.M. Siddesh, S. R. Manisekhar	Springer	1/e, 2020
2	Machine Learning Approaches to Bioinformatics.	Zheng Rong Yang	World Scientific	1/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning in Bioinformatics: Techniques and Applications in Practice.	Izadkhah, Habib.	Elsevier	1/e, 2022
2	Artificial Intelligence in Bioinformatics: From Omics Analysis to Deep Learning and Network Mining.	Agapito, Giuseppe, et al.	Elsevier	1/e, 2022.
3	Data Analytics in Bioinformatics: A Machine Learning Perspective.	Rabinarayan Satpathy et. al.	Wiley	1/e, 2021
4	Introduction to Machine Learning and Bioinformatics.	Michailidis, George, et al.	CRC Press	1/e, 2008
5	Machine Learning in Bioinformatics.	Zhang, Yanqing, Rajapakse, Jagath C.	Wiley	1/e, 2009

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLoNoar1DlEiltg7qYV5N-3846Pu1O2BAG&si=yri1r4CQzHC3MgT3

SEMESTER S6

ADVANCED DATABASE SYSTEMS

Course Code	**24SJPECST634**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To learn the fundamentals of data modeling, query processing, and design in advanced databases and study the working principles of distributed databases.
2. To learn emerging databases such as XML and NoSQL.
3. To enable the student to use tools, methodologies, and skills for working successfully with databases in today's global, data driven business model.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Query Processing and Optimization - Measures of query cost, Algorithms for Selection with cost analysis, Algorithms for Join with cost analysis, Evaluation of expressions; Heuristics in Query Optimization - Optimization of Relational Algebra expressions; Physical Database Design and Tuning - Introduction to Physical Database Design, Overview of Database Tuning, Tuning the Conceptual Schema, Tuning Queries and Views; Impact of Concurrency.	**9**
2	Distributed Databases - Distributed Systems, Introduction, Architecture, Distributed Database Concepts, Distributed Data Storage, Distributed Transactions, Commit Protocols, Concurrency Control; Query Processing and Decomposition - Query Processing Objectives, Characterization of Query Processors, Layers of Query Processing, Query Decomposition, Localization of Distributed Data.	**9**
3	XML and Non Relational Databases - Introduction to Semi Structured Data and XML Databases, XML Data Model – XSD, XML: DTD and XML	**9**

	Schema, XML Presentation, XPath Queries, XQuery; NoSQL Databases - CAP Theorem, Document based; MongoDB Operation - Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding, Deployment; Cassandra - Data Model, Key Space, Table Operations, CRUD Operations.	
4	Graph database - Introduction, Data Modelling with Graphs, Building a Graph Database application, Data Modeling, Predictive Analysis with Graph Theory; Depth and Breadth First Search; Path-Finding with Dijkstra's Algorithm; Graph Theory and Predictive Modeling	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions.

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply various measures for query processing and optimization and apply techniques to tune database performance.	**K3**
CO2	Explain the architecture and fundamental concepts of distributed databases.	**K2**
CO3	Utilize semi-structured data, XML, and XML queries for effective data Management and Utilize NoSQL database systems to manage and manipulate data in real- time applications	**K3**
CO4	Develop advanced skills in graph database concepts, covering data modeling, application building, and the application of graph theory for predictive analysis and modeling.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2								3
CO2	3	2	2								3
CO3	3	2	2		2						3
CO4	3	2	3		3						3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Database Systems	Ramez Elmasri, Shamkant B. Navathe	Pearson	7/e, 2017
2	Database System Concepts	A. Silberschatz, H. Korth, S. Sudarshan	McGraw-Hill	7/e, 2021
3	Database Management Systems	R. Ramakrishnan, J. Gehrke	McGraw Hill	3/e, 2018
4	Graph Databases	Ian Robinson, Jim Webber, Emil Eifrem	O'Reilly	2/e, 2015
5	Database Systems	T. M. Connolly, C. Begg	Pearson	6/e, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of Database Management: Practical Guide to Storing, Managing and Analyzing Big and Small Data	W. Lemahieu, S. Vanden Broucke B. Baesens	Cambridge University Press	1/e, 2018
2	Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems	M. Kleppmann	O'Reilly	1/e, 2017
3	Database Systems: The Complete Book	Hector Garcia-Molina Jeffrey D. Ullman Jennifer Widom	Prentice Hall	2/e, 2009
4	Next generation databases: NoSQL, and big data.	Guy Harrison	Apress	1/e, 2015
5	Foundations of Multidimensional and Metric Data Structures	Hanan Samet	Morgan Kaufmann	1/e, 2006

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtu.be/B9tS_JNbW00

SEMESTER S6

WEB MINING

Course Code	**24SJPEADT636**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To provide essential skills in web mining and social network analysis, covering theoretical foundations, association rule and sequential pattern mining, information retrieval, text preprocessing, advanced search techniques, and web crawling, preparing them to tackle real-world data analysis challenges effectively.
2. To impart in-depth knowledge and practical skills in structured data extraction and web usage mining, including wrapper generation, schema matching, and various extraction techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction – Web Mining – Theoretical background – Association rule mining – Sequential Pattern Mining -Information retrieval and Web search – Information retrieval Models-Relevance Feedback- Text and Web page Pre-processing – Inverted Index – Latent Semantic Indexing –Web Search – Meta-Search – Web Spamming.	9
2	Introduction -Social Networks Analysis- Co-Citation and Bibliographic Coupling- Page Rank: PageRank Algorithm, Link-Based Similarity Search, Enhanced Techniques for Page Ranking - HITS: HITS Algorithm, Finding Other Eigenvectors-Community Discovery: Problem Definition, Bipartite Core Communities. Web Crawling -A Basic Crawler Algorithm: Breadth-First Crawlers, Preferential Crawlers, Universal Crawlers- Focused Crawlers and Topical Crawlers	9

3	Structured Data Extraction: Wrapper Generation – Preliminaries- Wrapper Induction- Instance Based Wrapper Learning - Automatic Wrapper Generation: Problems - String Matching and Tree Matching -Multiple Alignment - Building DOM Trees - Extraction Based on a Single List Page and Multiple pages- Introduction to Schema Matching – Schema Level Match -Domain and Instance Level Matching – Extracting and Analysing Web Social Networks.	**9**
4	Web Usage Mining - Data Collection and Pre-Processing: Sources and Types of Data, Key Elements of Web Usage Data - Data Modelling for Web Usage Mining - Discovery and Analysis of Web Usage Patterns – Applications- Recommender Systems and Collaborative Filtering –Query Log Mining	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain data mining process and techniques, specifically those that are relevant to Web mining.	**K2**
CO2	Identify the use of Social Networks Analysis in Web Mining and basics of Information retrieval	**K3**
CO3	Use different web crawling algorithms, such as breadth-first, preferential, universal, focused, and topical crawlers, to evaluate their effectiveness in gathering and processing web data	**K3**
CO4	Apply advanced solutions for structured data extraction, including innovative methods for wrapper generation, automatic wrappers, and matching techniques for various web pages.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								3
CO2	3	3	3								2
CO3	3	3	3	2							3
CO4	3	3	3	2							3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data- Centric Systems and Applications)	Bing Liu,	Springer	2/e, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Mining the Web: Uncovering Patterns in Web Content, Structure, and Usage	Zdravko Markov, Daniel T. Larose	John Wiley & Sons,	1/e, 2007
2	Web Mining and Social Networking: Techniques and Applications	Guandong Xu, Yanchun Zhang, Lin Li,	Springer	1/e, 2010
3	Mining the Web: Discovering Knowledge from Hypertext Data	Soumen Chakrabarti	Morgan Kaufmann	1/e. 2002
4	Graph-Theoretic Techniques for Web Content Mining	Adam Schenke	World Scientific Publishing	1/e, 2005

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLLspfyoOYoQcI6Nno3gPkq0h5YSe81hsc&si=ACKZ-oeKeEyDXsQr

SEMESTER S6

FUNDAMENTALS OF CRYPTOGRAPHY

Course Code	**24SJPECST637**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To develop a foundational understanding of mathematical concepts in cryptography,
2. To gain comprehensive knowledge of cryptographic methods.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Number Theory - Divisibility and The Division Algorithm, The Euclidean Algorithm, Modular Arithmetic: The Modulus, Properties of Congruences, Modular Arithmetic Operations, The Extended Euclidean Algorithm, Primitive Roots, Existence of Primitive Roots for Primes, Fermat's Theorem, Euler's Totient Function, Euler's Theorem, Testing for Primality: Miller–Rabin Algorithm, A Deterministic Primality Algorithm, Discrete Logarithms, Chinese Remainder Theorem.	**10**
2	Security Attacks; Security Services; Security Mechanisms; Fundamental Security Design Principles; Cryptography - Symmetric Cipher Model, Substitution Techniques, Transposition techniques; Traditional Block Cipher Structure.	**8**
3	The Data Encryption Standard - DES Encryption & Decryption, Avalanche Effect, Strength of DES; Advanced Encryption Standard - AES Structure; Stream Ciphers; RC4; Principles of Public-Key Cryptosystems - Public- Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptography, The RSA Algorithm, Description of the Algorithm; Diffie–Hellman Key Exchange.	**10**

4	Cryptographic Hash Functions - Applications of Cryptographic Hash Functions, Secure Hash Algorithm (SHA), SHA-3; MAC; MD5; Digital Signatures.; Key Management and Distribution - Symmetric Key Distribution; X.509 certificates; PKI.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply number theory concepts in data security	**K3**
CO2	Explain the cryptographic concepts and apply the classical encryption methods for data confidentiality	**K3**
CO3	Describe the symmetric and asymmetric ciphers used for information security	**K2**
CO4	Explain the algorithms used for authentication and integrity	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2							2
CO2	3	3	3	2							2
CO3	3	3	3								2
CO4	3	3	3								2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cryptography & Network Security: Principles and practice	William Stallings	Pearson	7/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cryptography & Network Security	Behrouz A. Forouzan	McGraw Hill	3/E, 2007
2	Security in Computing	Charles P. Pfleeger, Shari L. Pfleeger, Jonathan Margulies	Prentice Hall	5/e, 2015
3	A Classical Introduction to Cryptography: Applications for Communications Security	S. Vaudenay	Springer	1/e, 2009
4	Introduction to Cryptography: Principles and Applications	H. Delfs, H. Knebl	Springer-Verlag	1/E, 2002

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PL71FE85723FD414D7&si=T9WKk6ZLrWJO9eMN

SEMESTER S6

QUANTUM COMPUTING

Course Code	**24SJPECST638**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To give an understanding of quantum computing against classical computing.
2. To understand fundamental principles of quantum computing, quantum algorithms and quantum information.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of Basics Concepts Review of linear algebra, Principles of quantum mechanics, Review of Information theory, Review of Theory of Computation. [Text 1 - Ch 1, 2; Text 2, Ch 11.1, 11.2]	**9**
2	Introduction to Quantum Information Qubit – Bloch sphere representation, Multiple qubit states, Quantum logic gates – single qubit and multi-qubit, Quantum circuits, Density matrix, Quantum entanglement. [Text 1 - Ch 3, 4; Text 2 - Ch 4]	**9**
3	Quantum Algorithms: - Simple Quantum Algorithms, Quantum Integral Transforms, Grover's Search Algorithm and Shor's Factorization Algorithm. [Text 1 - Ch 5,6,7,8]	**9**
4	Quantum Communication: - Von Neumann entropy, Holevo Bound, Data compression, Classical information over noisy quantum channels, Quantum information over noisy	**9**

	quantum channels, Quantum Key Distribution, Quantum Communication protocols [Text 2 - Ch 11.3, Ch 12.1 - 12.5]	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course, students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the concept of quantum computing against classical computing.	**K2**
CO2	Illustrate various quantum computing algorithms.	**K2**
CO3	Explain the latest quantum communication & protocols.	**K2**
CO4	Experiment with new algorithms and protocols for quantum computing.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3								2
CO2	3	2	3								2
CO3	3	2	3								2
CO4	3	2	3								2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Quantum Computing: From Linear Algebra to Physical Realizations	Mikio Nakahara Tetsuo Ohmi	CRC Press	1/e, 2008
2	Quantum Computation and Quantum Information	Michael A. Nielsen & Isaac L. Chuang	Cambridge University Press	1/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Quantum Computing for Programmers	Robert Hundt	Cambridge University Press	1/e, 2022
2	Quantum Computing for Everyone	Chris Bernhardt	MIT Press	1/e, 2020
3	An Introduction to Practical Quantum Key Distribution [paper]	Omar Amer Vaibhav Garg Walter O. Krawec	IEEE Aerospace and Electronic Systems Magazine	March 2021
4	Quantum communication [paper]	Nicolas Gisin & Rob Thew	Nature Photonics	March 2007

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLo4DhXMUkdvU9rZvEQYLdly5dABHvlZuD&si=px3a3vUtVVZ9R3vL

SEMESTER S6

NATURAL LANGUAGE PROCESSING

Course Code	**24SJPEADT635**	**CIE Marks**	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the comprehensive understanding of Natural Language Processing (NLP)
2. To discuss various parsing techniques and ambiguity resolution
3. To discuss the advanced semantic interpretation and knowledge representation

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Natural Language Understanding and Linguistics:** Levels of language analysis, Syntax, Semantics, Pragmatics. Linguistic Background, An Outline of English Syntax, Lexicon, POS Tagging, Word Senses. **Project 1**: Comprehensive Analysis of English Language Processing: Syntax, Semantics, and Pragmatics using NLTK and spaCy	**8**
2	**Parsing Techniques and Ambiguity Resolution:** Grammars and Parsing Features, Agreement and Augmented Grammars, Grammars for Natural Language, Parsing methods and Efficient Parsing, Ambiguity Resolution, Statistical Methods. Probabilistic Context Free Grammar. **Project 2**: Implementation and Evaluation of Probabilistic Context-Free Grammars (PCFG) for Natural Language Parsing using NLTK	**8**

3	**Semantic Interpretation and Knowledge Representation in NLP:** Semantics and Logical Form, Linking Syntax and Semantics, Ambiguity Resolution, other Strategies for Semantic Interpretation, Scoping and the Interpretation of Noun Phrases. Knowledge Representation and Reasoning, Local Discourse Context and Reference, Using World Knowledge, Discourse Structure, Defining a Conversational Agent. **Project 3**: Strategies for Semantic Interpretation and Ambiguity Resolution in NLP using NLTK and spaCy **Assignment:** Knowledge Representation and Reasoning for NLP Applications	**10**
4	**Language Models:** Pre-trained Models-BERT, GPT-2, ELMO, RoBERT Applications and Challenges- Machine Translation, Information Retrieval and Extraction, Sentiment Analysis, Text Categorization and Summarization. **Project 4**: Strategies for Semantic Interpretation and Ambiguity Resolution in NLP using NLTK and spaCy	**10**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Examination	Evaluate	Analyse	Total
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyse): 20 marks

1. Code Implementation (40%) – 8 Marks
   - Correctness (4 Marks): Implementation of the code correctly
   - Efficiency and Robustness (4 Marks): Code optimization for efficiency,
2. Results Analysis (60%) – 12 Marks
   - valuation Metrics (6 Marks): Proper use of evaluation metrics
   - Insightful Analysis (6 Marks): Interpretation of the results

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply syntax, semantics, and pragmatics in NLP tasks and explain accurate lexicon usage, POS tagging, and word sense disambiguation.	**K3**
CO2	Implement and utilize various grammars and parsing methods, including resolving ambiguities	**K3**
CO3	Link syntax and semantics, interpret noun phrases, and use knowledge representation for discourse management.	**K2**
CO4	Implement the models like BERT, GPT-2, ELMO, and RoBERT for tasks like machine translation, sentiment analysis, and text summarization	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3									3
CO2	3	3	3	3	3						3
CO3	3	3	3	3	3						3
CO4	3	3	3	3	3				3	3	3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Speech and Language Processing	D. Jurafsky and J. H. Martin	Prentice Hall India	1/e, 2000
2	Natural Language Understanding	James Allen	Benjamin-Cummings	1/e, 1988

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Artificial intelligence	Charniak Eugene	Addison-Wesley	1/e, 1985
2	Modern Information Retrieval	Ricardo Baeza-Yates and Berthier Ribeiro-Neto	Addison-Wesley	1/e, 1999
3	Natural Language Processing and Information Retrieval,	U. S. Tiwary and Tanveer Siddiqui	Oxford University Press	1/e, 2008

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtube.com/playlist?list=PLzJaFd3A7DZutMK8fFxZx_mhmFQgzijGE&si=KDCTv0wZqlrLvg9z

Programme Outcomes (POs)

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

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

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

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

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

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO8: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

PO09: 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.

PO10: 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 multi-disciplinary environments.

PO11: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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VISION

Developing into a world class, pace setting institute of Engineering and Technology with distinct identity and character, meeting the goals and aspirations of the society.

MISSION

- To maintain a conducive infrastructure and learning environment for world class education.
- To nurture a team of dedicated, competent and research-oriented faculty.
- To develop students with moral and ethical values, for their successful careers, by offering variety of programs and services.