



**ST. JOSEPH'S**  
COLLEGE OF ENGINEERING  
AND TECHNOLOGY,  
- PALAI -  
AUTONOMOUS

Choondacherry P.O., Pala, Kottayam - 686579  
Kerala, India



# SYLLABUS

**B.Tech.**

**COMPUTER SCIENCE AND ENGINEERING  
(ARTIFICIAL INTELLIGENCE)**

**2024 SCHEME**

**SEMESTER 5 & 6**

### FIFTH SEMESTER (July-December)

Sl. No:	Slot	Course Code	Course Type	Course Category	Course Title (Course Name)	Credit Structure					Total Marks		Credits	Hrs./ Week
						L	T	P	R	SS	CIA	ESE		
1	A	24SJPCST501	PC	PC	Computer Networks	3	1	0	0	5	40	60	4	4
2	B	24SJPCCAT502	PC	PC	Theory of Computation	3	1	0	0	5	40	60	4	4
3	C	24SJPCST503	PC	PC	Machine Learning	3	0	0	0	4.5	40	60	3	3
4	D	24SJPCAT504	PC-PBL	PB	Advanced Graph Algorithms	3	0	0	1	5.5	60	40	4	4
5	E	24SJPECAT52N	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	24SJPCCAL507	PCL	PC	AI Algorithms Lab	0	0	3	0	1.5	50	50	2	3
8	Q	24SJPCCSL508	PCL	PC	Machine Learning 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*
	S5/S6	Industrial Visit (Maximum 6 Days are permitted, Not Exceeding more than 4 Working Days) /Industrial Training												
<b>Total</b>										<b>30 / 35</b>			<b>23/27*</b>	<b>24/28*</b>

**\*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.

### PROGRAM ELECTIVE 2: 24SJPECAT52N

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
E	24SJPECST521	Software Project Management	3-0-0-0	3	3
	24SJPECAT522	Artificial Neural Networks Techniques	3-0-0-0		3
	24SJPECST523	Data Analytics	3-0-0-0		3
	24SJPECST526	Digital Signal Processing	3-0-0-0		3
	24SJPECST527	Computer Graphics & Multimedia	3-0-0-0		3
	24SJPECST528	Advanced Computer Architectures	3-0-0-0		3
	24SJPECAT520	Industry Elective	3-0-0-0		3
	24SJPECST525	<b>Data Mining</b>	<b>3-0-0-1</b>		<b>5/3</b>
	24SJPECAT595	<b>Foundations of Security in Computing</b>	<b>3-0-0-1</b>		<b>5/3</b>

### SIXTH SEMESTER (January-June)

Sl. No:	Slot	Course Code	Course Type	Course Category	Course Title (Course Name)	Credit Structure					Total Marks		Credits	Hrs/Week
						L	T	P	R	SS	CIA	ESE		
1	A	24SJPCCAT601	PC	PC	Natural Language Processing	3	1	0	0	5	40	60	4	4
2	B	24SJPCCAT602	PC	PC	Robotics and Automation	3	0	0	0	4.5	40	60	3	3
3	C	24SJPECAT63N/ 24SJPECST63N	PE	PE	PE-3	3	0	0	0	4.5	40	60	3	3
4	D	24SJPCCAT604	PC-PBL	PB	Introduction to Deep Learning	3	0	0	1	5.5	60	40	4	4
5	F	24SJGAEST605	ESC	GC	Design Thinking and Product Development (Group Specific Syllabus)	2	0	0	0	3	40	60	2	2
6	O	24SJOE--T61N/ /24SJIE--T61N	OE/ILE	OE	OE/ILE-1	3	0	0	0	4.5	40	60	3	3
7	L	24SJPCCAL607	PCL	PC	Robotics Lab	0	0	3	0	1.5	50	50	2	3
8	P	24SJPCSP608	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												
<b>Total</b>										<b>32 /</b>			<b>23/26*</b>	<b>25/28*</b>

**Note: Open Electives are such courses which will be offered by other departments. Like CSE 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.

#### PROGRAM ELECTIVE 3: 24SJPECAT63N/24SJPECST63N

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
C	24SJPECST631	Software Testing	3-0-0-0	3	3
	24SJPECAT632	Introduction to Business Analytics	3-0-0-0		3
	24SJPECAT633	AI For Cyber Security	3-0-0-0		3
	24SJPECAT634	Wireless Sensor Networks	3-0-0-0		3
	24SJPECST636	Digital Image Processing	3-0-0-0		3
	24SJPECAT637	Embedded Systems and its Applications	3-0-0-0		3
	24SJPECST635	<b>Cloud Computing</b>	<b>3-0-0-1</b>		<b>5/3</b>
	24SJPECST630	<b>Mobile Application Development</b>	<b>3-0-0-1</b>		<b>5/3</b>

**OPEN ELECTIVE 1: 24SJOECST61N**

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
<b>O</b>	24SJOECST611	Data Structures	3-0-0-0	<b>3</b>	3
	24SJOECST612	Data Communication	3-0-0-0		3
	24SJOECST613	Foundations of Cryptography	3-0-0-0		3
	24SJOECST614	Machine Learning for Engineers	3-0-0-0		3
	24SJOECST615	Object Oriented Programming	3-0-0-0		3



## SEMESTER S5

### COMPUTER NETWORKS

(Common to CS/AD/CA)

<b>Course Code</b>	<b>24SJPCST501</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:1:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	4	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	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.

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
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). <i>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)</i> Network Layer: Introduction, Network-layer protocols, IP Addressing, Unicast routing, Multicast routing - Multicasting Basics, Intra domain and inter-domain routing, Next generation IP (Book 1 Ch 4), Congestion Control, Quality of Service (Book 1 Ch 8) <i>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)</i>	20
3	Data-Link Layer: Data link control (DLC), Flow Control, Error Control, Multiple access protocols (MAC), Link-layer addressing, Ethernet protocol, Connecting devices (Book 1 Ch 5) Wireless LANs, Mobile IP (Book 1 Ch 6) <i>Hands-on: Datalink Provider Interface, SOCK_PACKET and PF_PACKET (Book 2 Ch 29)</i>	
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)	6

**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
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

## Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Understand the internetworking design in terms of protocol stack and the role of various application layer protocols	<b>K2</b>
<b>CO2</b>	Illustrate the functions of the transport layer from connectionless and connection-oriented perspectives	<b>K3</b>
<b>CO3</b>	Identify how the network layer achieves host-to-host connectivity and caters to the diverse service requirements of the host applications	<b>K3</b>
<b>CO4</b>	Explain the nuances of the data link layer design and demonstrate the various data link link layer protocols	<b>K3</b>
<b>CO5</b>	Describe the fundamental characteristics of the physical layer and understand how the physical layer supports the functionalities of the top layers	<b>K2</b>

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
<b>CO1</b>	✓	✓									✓
<b>CO2</b>	✓	✓	✓	✓							✓
<b>CO3</b>	✓	✓	✓	✓	✓						✓
<b>CO4</b>	✓	✓		✓							✓
<b>CO5</b>	✓	✓									✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
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

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
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

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>No.</b>	<b>Link ID</b>
1	<a href="https://nptel.ac.in/courses/106105183">https://nptel.ac.in/courses/106105183</a>

## SEMESTER 5

### THEORY OF COMPUTATION

<b>Course Code</b>	24SJPCCAT502	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:1:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	4	<b>Exam Hours</b>	2 Hrs 30 Mins
<b>Prerequisites (if any)</b>	24SJPCST205	<b>Course Type</b>	Theory

#### Course Objectives:

1. To introduce the concept of formal languages.
2. To discuss the Chomsky classification of formal languages with a discussion on grammar and automata for regular, context-free, context-sensitive, and unrestricted languages.
3. To discuss the notions of decidability and the halting problem.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Foundations (Linz, Hopcroft)</b> Motivation for studying computability, need for mathematical modelling - automata, Introducing automata through simple models - On/Off switch. Three basic concepts: Alphabet, Strings, and Languages <b>Finite Automata (Linz, Hopcroft)</b> Formal definition of a finite automaton, Design of Deterministic Finite Automata (DFA), Regular languages. Formal definition of a nondeterministic finite automaton, Design of Non-Deterministic Finite Automata (NFA), NFA with epsilon transitions, Eliminating epsilon transitions (Proof not expected), Equivalence of NFAs and DFAs (Proof not expected) - The Subset Construction. DFA State Minimization, Applications of finite automata - text search, keyword recognition	<b>11</b>
<b>2</b>	<b>Regular Expressions (Linz)</b> The formal definition of a regular expression, Building Regular Expressions, Equivalence with finite automata (Proof not expected) – Converting FA to Regular Expressions, Converting Regular Expressions to FA. Regular grammar.	

	<p><b>Properties of Regular Languages (Linz)</b>  Closure and Decision Properties of Regular Languages (with proofs), The Pumping Lemma for Regular Languages (with formal proof), Pumping lemma as a tool to prove non-regularity of languages</p> <p><b>Context-Free Grammars and Applications (Linz)</b>  Formal definition of context-free grammar, Designing context-free grammar, Leftmost and Rightmost Derivations Using Grammar, Parse Trees, Ambiguous Grammars, CFGs and programming languages</p>	11
3	<p><b>Pushdown Automata (Linz)</b>  Formal definition of a pushdown automaton, DPDA and NPDA, Design of pushdown automata, Equivalence of acceptance by empty stack and acceptance by final state (PDA).</p> <p><b>Simplification of Context-Free Languages (Linz)</b>  Elimination of useless symbols and productions, Eliminating epsilon productions, Eliminating unit productions, Chomsky normal form, Greibach - normal form,</p> <p><b>Properties of Context-Free Languages (Linz)</b>  The Pumping Lemma for Context-Free Languages (with formal proof), Closure and Decision Properties of Context-Free Languages (with formal proofs)</p>	11
4	<p><b>Turing Machines (Kozen)</b>  The formal definition of a Turing machine, Examples of Turing machines – Design of Turing machines as language acceptors, Design of Turing machines as Transducer, Variants of Turing Machines (Proofs for equivalence with the basic model not expected), Recursive and recursively enumerable languages  Chomsky hierarchy, Formal definition of Linear bounded automaton as a restricted TM.</p> <p><b>Computability (Kozen)</b>  Church Turing thesis, Encoding of TMs, Universal Machine. Decidable Undecidable Problems, Halting Problems, Post Correspondence Problems and the proofs for their undecidability.</p>	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
<ul style="list-style-type: none"> <li>2 Questions from each module.</li> <li>Total of 8 Questions, each carrying 3 marks</li> </ul> <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> <li>Each question carries 9 marks.</li> <li>Two questions will be given from each module, out of which 1 question should be answered.</li> <li>Each question can have a maximum of 3 subdivisions.</li> </ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

### Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Classify formal languages into regular, context-free, context-sensitive, and unrestricted languages.	<b>K2</b>
<b>CO2</b>	Develop finite state automata, regular grammar, and regular expression.	<b>K3</b>
<b>CO3</b>	Model push-down automata and context-free grammar representations for context-free languages.	<b>K3</b>
<b>CO4</b>	Construct Turing Machines to accept recursive and recursively enumerable languages.	<b>K3</b>
<b>CO5</b>	Describe the notions of decidability and undecidability of problems, the Halting problem.	<b>K2</b>

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
<b>CO1</b>	✓	✓	✓	✓							✓
<b>CO2</b>	✓	✓	✓	✓							✓
<b>CO3</b>	✓	✓	✓	✓							✓
<b>CO4</b>	✓	✓	✓	✓							✓
<b>CO5</b>	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	An Introduction to Formal Languages and Automata	Peter Linz and Susan H. Rodger	Jones and Bartlett Publishers, Inc	7/e, 2022
2	Introduction to Automata Theory Languages And Computation	John E.Hopcroft, Jeffrey D.Ullman	Rainbow Book Distributors	3/e, 2015
3	Automata and Computability	Dexter C. Kozen	Springer	1/e,2007

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Introduction to the Theory of Computation	Michael Sipser	Cengage India Private Limited	3/e, 2014
2	Introduction to Languages and the Theory of Computation	John C Martin	McGraw-Hill Education	4/e, 2010
3	Theory of Computation: A Problem-Solving Approach	Kavi Mahesh	Wiley	1/e, 2012
4	Elements of the Theory of Computation	Harry R. Lewis, Christos Papadimitriou	Pearson Education	2/e, 2015

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Module No.</b>	<b>Link ID</b>
<b>1</b>	<a href="https://nptel.ac.in/courses/106106049">https://nptel.ac.in/courses/106106049</a>
<b>2</b>	<a href="https://nptel.ac.in/courses/106106049">https://nptel.ac.in/courses/106106049</a>
<b>3</b>	<a href="https://nptel.ac.in/courses/106106049">https://nptel.ac.in/courses/106106049</a>
<b>4</b>	<a href="https://nptel.ac.in/courses/106106049">https://nptel.ac.in/courses/106106049</a>

## SEMESTER 5

### MACHINE LEARNING

(Common to CS/AD/CA/CC)

<b>Course Code</b>	<b>24SJPCST503</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	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

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
1	<b>Introduction to ML :-</b> Machine Learning vs. Traditional Programming, Machine learning paradigms - supervised, semi-supervised, unsupervised, reinforcement learning. Parameter Estimation - Maximum likelihood estimation (MLE) and maximum a posteriori estimation (MAP), Bayesian formulation. <b>Supervised Learning :-</b> 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	<b>Classification</b> - 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

<b>4</b>	<p><b>Unsupervised Learning</b></p> <p>Clustering - Similarity measures, Hierarchical Clustering - Agglomerative Clustering, partitional clustering, K-means clustering</p> <p>Dimensionality reduction - Principal Component Analysis, Multidimensional scaling</p> <p>Ensemble methods - bagging, boosting; Resampling methods - Bootstrapping, Cross Validation. Practical aspects - Bias-Variance tradeoff.</p>	<b>9</b>
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**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
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

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
<ul style="list-style-type: none"> <li>● 2 Questions from each module.</li> <li>● Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>● Each question carries 9 marks.</li> <li>● Two questions will be given from each module, out of which 1 question should be answered.</li> <li>● Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

## Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Illustrate Machine Learning concepts and basic parameter estimation methods.	<b>K2</b>
<b>CO2</b>	Demonstrate supervised learning concepts (regression, classification).	<b>K3</b>
<b>CO3</b>	Illustrate the concepts of Multilayer neural network and Decision trees	<b>K3</b>
<b>CO4</b>	Describe unsupervised learning concepts and dimensionality reduction techniques	<b>K3</b>
<b>CO5</b>	Use appropriate performance measures to evaluate machine learning models	<b>K3</b>

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

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

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
<b>CO1</b>	✓	✓									
<b>CO2</b>	✓	✓		✓	✓						
<b>CO3</b>	✓	✓		✓	✓						
<b>CO4</b>	✓	✓		✓	✓						✓
<b>CO5</b>		✓		✓	✓				✓		

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
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

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
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

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>No.</b>	<b>Link ID</b>
1	<a href="https://nptel.ac.in/courses/106106202">https://nptel.ac.in/courses/106106202\</a>

## SEMESTER 5

### ADVANCED GRAPH ALGORITHMS

<b>Course Code</b>	<b>24SJPBCAT504</b>	<b>CIE Marks</b>	60
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:1	<b>ESE Marks</b>	40
<b>Credits</b>	4	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	24SJGAMAT401	<b>Course Type</b>	Theory

#### Course Objectives:

1. To provide a comprehensive understanding of the fundamental concepts of graphs and trees.
2. To learn matching and covering algorithms, connectivity and path effectively.
3. To equip the learner to apply vertex coloring, planar graph, Line graph and edge coloring effectively.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Introduction to Graphs & its Applications, Basics of Paths, Cycles, and Trails, Connection, Bipartite Graphs, Eulerian Circuits, Vertex Degrees and Counting, Degree-sum formula, The Chinese Postman Problem and Graphic Sequences. Trees and Distance, Properties of Trees, Spanning Trees and Enumeration, Matrix-tree computation, Cayley's Formula.	<b>12</b>
<b>2</b>	Matchings and Covers, Hall's Condition, Min-Max Theorem, Independent Sets, Covers and Maximum Bipartite Matching, Augmenting Path Algorithm, Weighted Bipartite Matching, Hungarian Algorithm. Stable Matchings and Faster Bipartite Matching, Factors & Perfect Matching in General Graphs, Matching in General Graphs: Edmonds' Blossom Algorithm	<b>12</b>
<b>3</b>	Connectivity and Paths: Cuts and Connectivity, k-Connected Graphs, Network Flow Ford-Fulkerson Labeling Algorithm, Max-Flow Min-cut	<b>10</b>
<b>4</b>	Planar Graphs, Characterization of Planar Graphs, Kuratowski's Theorem, Wagner's Theorem Line Graphs and Edge-coloring, Hamiltonian Graph, Traveling Salesman Problem and NP-Completeness, Dominating Sets.	<b>10</b>

#### Suggestion on Project Topics

- Applications of advanced graph theory in routing, social network analysis, disease spreading models etc.

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

**Continuous Internal Evaluation Marks (CIE):**

Attendance	Project	Internal Examination-1	Internal Examination-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
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)</li> </ul>	<ul style="list-style-type: none"> <li>• 2 questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 2 sub divisions.</li> <li>• Each question carries 6 marks. (4x6 = 24 marks)</li> </ul>	<b>40</b>

**Course Outcomes (COs)**

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain fundamental graph concepts and algorithms to analyse and solve problems involving paths, cycles, trees, and network optimization.	<b>K3</b>
<b>CO2</b>	Illustrate matching and covering problems in graphs using algorithms and theorems, including Hall's Condition, the Min-Max Theorem, and the Hungarian Algorithm.	<b>K3</b>
<b>CO3</b>	Apply connectivity and paths including Network Flow Ford-Fulkerson Labeling Algorithm, Max-Flow Min-cut Theorem, Menger's Proof using Max-Flow Min-Cut Theorem	<b>K3</b>
<b>CO4</b>	Illustrate Vertex Coloring and Upper Bounds, Brooks' Theorem and Color-Critical Graphs, Counting Proper Colorings.	<b>K3</b>
<b>CO5</b>	Apply concepts of planar graphs, including Kuratowski's and Wagner's theorems, to analyze graph planarity and edge-coloring, while solving complex problems related to Hamiltonian graphs, the Traveling Salesman Problem, and dominating sets	<b>K3</b>

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	✓	✓	✓								✓
CO2	✓	✓	✓								✓
CO3	✓	✓	✓								✓
CO4	✓	✓	✓								✓
CO5	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Graph Theory	D.B. West	Pearson Publication	2/e, 2001
2	Introduction to Graph Theory	Robin J. Wilson	Longman Group Ltd	5/ e, 2015
3	Graph theory with Applications	J.A. Bondy and U.S.R. Murty.	Elsevier Science Publishing Co., Inc	1/e, 1982

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Graph Theory	R.Diestel	Springer	4/e, 2010
2	Graph theory and its application	Jay Yellen, Jonathan L. Gross, et al.	CRC press	3/e, 2019
3	Modern Graph Theory	Bela Bollobas	Springer	1/e, 1998
4	Network Flows: Theory, Algorithms, and Applications	Ravindra Ahuja, Thomas Magnanti, et al.	Prentice-Hall	1/e, 1993

### Video Links (NPTEL, SWAYAM...)

Module No.	Link ID
1	<a href="https://onlinecourses.nptel.ac.in/noc21_cs48/preview">https://onlinecourses.nptel.ac.in/noc21_cs48/preview</a>
2	(14) Graph Theory by Sarada Herke - YouTube
3	(14) Graph Algorithms - YouTube
4	(14) distanceedjohn - YouTube

### 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
<b>Total</b>		<b>30</b>

**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 5

### AI ALGORITHMS LAB

<b>Course Code</b>	<b>24SJPCCAL507</b>	<b>CIE Marks</b>	50
<b>Teaching Hours/Week (L: T:P: R)</b>	0:0:3:0	<b>ESE Marks</b>	50
<b>Credits</b>	2	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Practical

#### Course Objectives:

1. To implement and optimize search and game algorithms.
2. To write programs for constraint satisfaction and scheduling problems.
3. To enable the learners to build and evaluate machine learning and expert systems.

*A minimum of ten experiments must be completed as part of the course requirements.*

<b>Expt. No.</b>	<b>Experiments</b>
1	Implement basic search strategies 8-puzzle problem
2	Implement variants of hill-climbing and genetic algorithms.
3	Implement A* Algorithm
4	Implement Mini-Max algorithm for game playing (Alpha-Beta pruning)
5	Solve constraint satisfaction problems
6	Implement Forward Chaining Algorithm
7	Implement Naïve Bayes Models.
8	The airline scheduling problem, where the objective is to schedule flights to maximize resource utilization while minimizing delays. Key factors include aircraft availability, crew schedules, and airport slot times. Constraints involve regulatory requirements, maintenance schedules, and airport capacities.
9	In a timetabling problem, variables are the classes or exams to be scheduled. Constraints include avoiding scheduling conflicts, ensuring that no two classes occur at the same time for a given student and meeting room availability. Possible values are the time slots and locations for each class.
10	Write a program to build and train a decision tree classifier using a library (e.g., scikit-learn). Evaluate the model using metrics such as accuracy and confusion matrix. Discuss pre-processing steps, training process, and performance evaluation.
11	Implement a Sudoku solver using backtracking or constraint propagation techniques. Describe how constraints are checked and how the algorithm searches for a valid solution. Provide examples of how the solver handle different Sudoku puzzles.

12	Develop a simple expert system using a tool or language of your choice (e.g., Prolog, Python with an expert system library). Implement the system for a given problem and test its performance.
13	Develop a program to construct a pruned game tree using Alpha-Beta pruning. Take the sequence, [5, 3, 2, 4, 1, 3, 6, 2, 8, 7, 5, 1, 3, 4] of MINIMAX values for the nodes at the cutoff depth of 4 plies. Assume that branching factor is 2, MIN makes the first move, and nodes are generated from right to left.
14	Implementation of Knowledge representation schemes
15	Implement local search algorithms for CSP
16	Implement travelling salesman problem

**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

*Note: 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.*

**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 Outcomes		Bloom's Knowledge Level (KL)
CO1	Apply Search Algorithms to Solve Complex Problems	K3
CO2	Develop and Optimize Constraint Satisfaction Solutions.	K3
CO3	Implement and Evaluate Machine Learning Models	K3
CO4	Build and Test Expert Systems.	K3
CO5	Utilize Advanced Optimization Techniques	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	✓	✓	✓								✓
CO2	✓	✓	✓								✓
CO3	✓	✓	✓								✓
CO4	✓	✓	✓								✓
CO5	✓	✓	✓								✓

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to AI and ES	Dan W. Patterson	Pearson	1/e, 2007
2	Artificial Intelligence	Kevin Night, Elaine Rich, and Nair B	McGraw Hill	3/e, 2018
3	Artificial Intelligence by Example	Dennis Rothman	Packt	1/e, 2018
4	Artificial Intelligence	Patrick H. Winston	Pearson	3/e, 2006

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	<a href="https://youtu.be/yMcZvZayJUA">https://youtu.be/yMcZvZayJUA</a>
2	<a href="https://youtu.be/ZOvRZ7UJMjk">https://youtu.be/ZOvRZ7UJMjk</a> <a href="https://youtu.be/dtGRmhZ6Cuo">https://youtu.be/dtGRmhZ6Cuo</a>
3	<a href="https://youtu.be/a2tqR2eUlek">https://youtu.be/a2tqR2eUlek</a> <a href="https://youtu.be/il20Q5tXp-A">https://youtu.be/il20Q5tXp-A</a>
4	<a href="https://youtu.be/0oqhN5tvLgA">https://youtu.be/0oqhN5tvLgA</a> <a href="https://youtu.be/i3L4G1ZO7_E">https://youtu.be/i3L4G1ZO7_E</a>

### 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 5**  
**MACHINE LEARNING LAB**

(Common to CS/CA)

<b>Course Code</b>	<b>24SJPCCSL508</b>	<b>CIE Marks</b>	50
<b>Teaching Hours/Week (L: T:P: R)</b>	0:0:3:0	<b>ESE Marks</b>	50
<b>Credits</b>	2	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Lab

**Course Objectives:**

- To give the learner a practical experience of the various machine learning techniques and be able to demonstrate them using a language of choice.

*A minimum of ten experiments must be completed as part of the course requirements.*

Expt. No.	Experiments
1	Implement linear regression with one variable on the California Housing dataset to predict housing prices based on a single feature (e.g., the average number of rooms per dwelling). Tasks: <ul style="list-style-type: none"> <li>● Load and preprocess the dataset.</li> <li>● Implement linear regression using both gradient descent and the normal equation.</li> <li>● Evaluate the model performance using metrics such as Mean Squared Error (MSE) and R-squared.</li> <li>● Visualize the fitted line along with the data points.</li> </ul>
2	Implement polynomial regression on the Auto MPG dataset to predict miles per gallon (MPG) based on engine displacement. Compare polynomial regression results with linear regression.           Tasks: <ul style="list-style-type: none"> <li>● Load and preprocess the dataset.</li> <li>● Implement polynomial regression of varying degrees.</li> <li>● Compare the polynomial regression models with linear regression using metrics such as MSE and R-squared.</li> <li>● Visualize the polynomial fit.</li> </ul>
3	Implement Ridge and Lasso regression on the Diabetes dataset. Compare the performance of these regularized models with standard linear regression.           Tasks: <ul style="list-style-type: none"> <li>● Load and preprocess the dataset.</li> <li>● Implement Ridge and Lasso regression.</li> <li>● Tune hyperparameters using cross-validation.</li> <li>● Compare performance metrics (MSE, R-squared) with standard linear regression.</li> </ul>

4	<p>Estimate the parameters of a logistic regression model using MLE and MAP on the Breast Cancer Wisconsin dataset. Compare the results and discuss the effects of regularization.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the dataset.</li> <li>• Implement logistic regression with MLE.</li> <li>• Apply MAP estimation with different regularization priors (L1 and L2 regularization).</li> <li>• Compare the performance and parameter estimates with MLE and MAP.</li> </ul>
5	<p>Use MLE and MAP to estimate the parameters of a multinomial distribution on the 20 Newsgroups dataset. Explore the impact of different priors on the estimation.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the dataset.</li> <li>• Implement MLE for multinomial distribution parameter estimation.</li> <li>• Apply MAP estimation with various priors (e.g., Dirichlet priors).</li> <li>• Compare results and evaluate the effect of different priors.</li> </ul>
6	<p>Implement a logistic regression model to predict the likelihood of a disease using the Pima Indians Diabetes dataset. Compare the performance with and without feature scaling.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Pima Indians Diabetes dataset.</li> <li>• Implement logistic regression for binary classification.</li> <li>• Evaluate model performance with and without feature scaling.</li> <li>• Analyze metrics such as accuracy, precision, recall, and F1-score.</li> </ul>
7	<p>Implement a Naïve Bayes classifier to categorize text documents into topics using the 20 Newsgroups dataset. Compare the performance of Multinomial Naïve Bayes with Bernoulli Naïve Bayes.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the 20 Newsgroups dataset.</li> <li>• Implement Multinomial Naïve Bayes and Bernoulli Naïve Bayes classifiers.</li> <li>• Evaluate and compare the performance of both models using metrics such as accuracy and F1-score.</li> <li>• Discuss the strengths and weaknesses of each Naïve Bayes variant for text classification.</li> </ul>
8	<p>Implement the K-Nearest Neighbors (KNN) algorithm for image classification using the Fashion MNIST dataset. Experiment with different values of K and analyze their impact on model performance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Fashion MNIST dataset.</li> <li>• Implement KNN for multi-class classification.</li> <li>• Experiment with different values of K and evaluate performance.</li> <li>• Discuss the impact of different K values on model accuracy and computational efficiency.</li> </ul>

9	<p>Implement a Decision Tree classifier using the ID3 algorithm to segment customers based on their purchasing behavior using the Online Retail dataset. Analyze the tree structure and discuss the feature importance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Online Retail dataset.</li> <li>• Implement Decision Tree using the ID3 algorithm.</li> <li>• Visualize the decision tree and analyze feature importance.</li> <li>• Discuss how the tree structure helps in understanding customer behavior.</li> </ul>
10	<p>Implement and compare Logistic Regression and Decision Trees on the Adult Income dataset for predicting income levels. Evaluate both models based on performance metrics and interpretability.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Adult Income dataset.</li> <li>• Implement both Logistic Regression and Decision Trees.</li> <li>• Compare the models based on metrics such as accuracy, precision, recall, and F1- score.</li> <li>• Discuss the interpretability of both models and their suitability for the dataset.</li> </ul>
11	<p>Implement a Linear Support Vector Machine (SVM) to classify the Iris dataset. Visualize the decision boundary and discuss how the margin is determined.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Iris dataset.</li> <li>• Implement a Linear SVM for binary classification (e.g., classify Setosa vs. Non- Setosa).</li> <li>• Visualize the decision boundary and margin.</li> <li>• Discuss the concept of the margin and how it influences classification.</li> </ul>
12	<p>Implement and compare the performance of SVM classifiers with linear, polynomial, and RBF kernels on the Fashion MNIST dataset. Analyze the advantages and disadvantages of each kernel type.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Fashion MNIST dataset.</li> <li>• Implement SVM with linear, polynomial, and RBF kernels.</li> <li>• Compare the classification performance for each kernel.</li> <li>• Discuss the strengths and weaknesses of each kernel type.</li> </ul>
13	<p>Implement and train a Multilayer Feed-Forward Network (MLP) on the Wine Quality dataset. Experiment with different numbers of hidden layers and neurons, and discuss how these choices affect the network's performance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Wine Quality dataset.</li> <li>• Design and implement an MLP with varying architectures (different hidden layers and neurons).</li> <li>• Train and evaluate the network.</li> <li>• Discuss the impact of architecture choices on performance.</li> </ul>

14	<p>Implement and compare the performance of a neural network using different activation functions (Sigmoid, ReLU, Tanh) on the MNIST dataset. Analyze how each activation function affects the training process and classification accuracy.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the MNIST dataset.</li> <li>• Implement neural networks using Sigmoid, ReLU, and Tanh activation functions.</li> <li>• Train and evaluate each network.</li> <li>• Compare training times, convergence, and classification accuracy.</li> </ul>
15	<p>Implement and perform hyperparameter tuning for a neural network on the Fashion MNIST dataset. Experiment with different learning rates, batch sizes, and epochs, and discuss the impact on model performance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Fashion MNIST dataset.</li> <li>• Experiment with different hyperparameters (learning rate, batch size, epochs).</li> <li>• Train and evaluate the network.</li> <li>• Discuss how hyperparameter choices affect model performance.</li> </ul>
16	<p>Implement and compare hierarchical (agglomerative) and partitional (K-means) clustering algorithms on the Mall Customers dataset. Discuss the strengths and weaknesses of each method based on clustering results and evaluation metrics.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Mall Customers dataset.</li> <li>• Apply both hierarchical (agglomerative) and K-means clustering. Compare results using metrics such as inertia, silhouette score, and clustering visualization.</li> <li>• Discuss the advantages and disadvantages of each clustering method.</li> </ul>
17	<p>Implement and apply K-means clustering to the Digits dataset. Experiment with different numbers of clusters and evaluate the clustering results using metrics such as inertia and silhouette score. Analyze how the choice of K affects clustering performance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Digits dataset.</li> <li>• Implement K-means clustering with various numbers of clusters.</li> <li>• Evaluate clustering performance using inertia and silhouette score. Analyze the impact of the number of clusters on clustering quality.</li> </ul>
18	<p>Implement bootstrapping and cross-validation on the Iris dataset. Compare the model performance metrics (e.g., accuracy, F1-score) obtained using these resampling methods. Discuss the advantages and disadvantages of each method.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Iris dataset.</li> <li>• Implement bootstrapping to generate multiple samples and evaluate the model.</li> <li>• Implement k-fold cross-validation and evaluate the model.</li> <li>• Compare the performance metrics and discuss the pros and cons of each resampling method.</li> </ul>

19	<p>Implement bagging and boosting ensemble methods on the Titanic dataset. Compare the performance of both methods in terms of accuracy, precision, recall, and F1-score. Discuss how each method improves model performance and their respective strengths and weaknesses.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Titanic dataset.</li> <li>• Implement bagging using a base classifier (e.g., decision tree) and evaluate performance.</li> <li>• Implement boosting using a boosting algorithm (e.g., AdaBoost) and evaluate performance.</li> <li>• Compare performance metrics and discuss the strengths and weaknesses of each method.</li> </ul>
20	<p>Investigate the bias-variance tradeoff using polynomial regression on the Boston Housing dataset. Plot the training and validation errors for various polynomial degrees and discuss the tradeoff between bias and variance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> <li>• Load and preprocess the Boston Housing dataset.</li> <li>• Implement polynomial regression with varying degrees.</li> <li>• Plot training and validation errors for each degree.</li> <li>• Discuss the bias-variance tradeoff and its impact on model performance.</li> </ul>

**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

*Note: 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.*

**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 Outcomes		Bloom's Knowledge Level (KL)
<b>CO1</b>	Understand complexity of Machine Learning algorithms and their limitations;	<b>K2</b>
<b>CO2</b>	Understand modern notions in data analysis-oriented computing;	<b>K2</b>
<b>CO3</b>	Apply common Machine Learning algorithms in practice and implement their own.	<b>K3</b>
<b>CO4</b>	Performing experiments in Machine Learning using real-world data.	<b>K3</b>

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

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

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
<b>CO1</b>	✓	✓		✓	✓						✓
<b>CO2</b>	✓	✓		✓	✓						✓
<b>CO3</b>	✓	✓	✓	✓	✓			✓	✓		✓
<b>CO4</b>	✓	✓	✓	✓	✓			✓	✓		✓

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

### 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	Machine Learning using Python	Manaranjan Pradhan   U Dinesh Kumar	Wiley	1/e, 2019
3	Machine Learning: Theory and Practice	M.N. Murty, V.S. Anathanarayana	Universities Press	1/e, 2024

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
<b>1</b>	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki   Wagner Meira	Cambridge University Press	1/e, 2016
<b>2</b>	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1/e, 1998
<b>Video Links (NPTEL, SWAYAM...)</b>				
<b>No.</b>	<b>Link ID</b>			
<b>1</b>	<a href="https://archive.nptel.ac.in/courses/106/105/106105152/">https://archive.nptel.ac.in/courses/106/105/106105152/</a>			
<b>2</b>	<a href="https://archive.nptel.ac.in/courses/106/106/106106139/">https://archive.nptel.ac.in/courses/106/106/106106139/</a>			
<b>3</b>	<a href="https://nptel.ac.in/courses/106106202">https://nptel.ac.in/courses/106106202</a>			

### **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 II

## SEMESTER 5

### SOFTWARE PROJECT MANAGEMENT

(Common CS/CA/AD)

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

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Project scheduling and feasibility study :-</b> 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.	<b>8</b>
<b>2</b>	<b>Resource Scheduling, Cost Control and Project management Features :-</b> 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.	<b>8</b>
<b>3</b>	<b>Agile Project Management :-</b> 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.	<b>9</b>

<b>4</b>	<b>Scrum and DevOps in project management :-</b> 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.	<b>11</b>
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**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
<ul style="list-style-type: none"> <li>● 2 Questions from each module.</li> <li>● Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>● Each question carries 9 marks.</li> <li>● Two questions will be given from each module, out of which 1 question should be answered.</li> <li>● Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

## Course Outcomes (COs)

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

Course Outcomes		Bloom's Knowledge Level (KL)
<b>CO1</b>	Understand how effectively plan, and schedule projects within time and cost targets	<b>K2</b>
<b>CO2</b>	Apply project estimation and evaluation techniques to real world problem	<b>K3</b>
<b>CO3</b>	Discuss different Agile Project Methodologies	<b>K2</b>
<b>CO4</b>	Apply various SCRUM practices in project management.	<b>K3</b>
<b>CO5</b>	Demonstrate the techniques used in DevOps.	<b>K3</b>

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

### CO-PO Mapping Table:

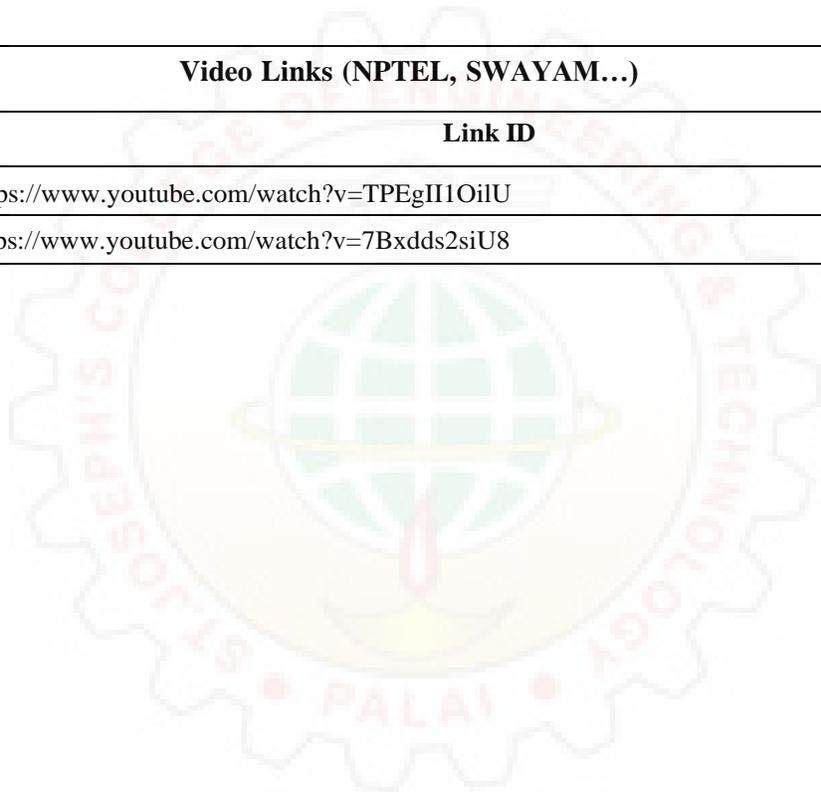
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
<b>CO1</b>	✓	✓	✓							✓	✓
<b>CO2</b>	✓	✓	✓							✓	✓
<b>CO3</b>	✓	✓	✓							✓	✓
<b>CO4</b>	✓	✓	✓							✓	✓
<b>CO5</b>	✓	✓	✓							✓	✓

### Text Books

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

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

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>No.</b>	<b>Link ID</b>
<b>1</b>	<a href="https://www.youtube.com/watch?v=TPEgII1Oiu">https://www.youtube.com/watch?v=TPEgII1Oiu</a>
<b>2</b>	<a href="https://www.youtube.com/watch?v=7Bxdds2siU8">https://www.youtube.com/watch?v=7Bxdds2siU8</a>



## SEMESTER 5

### ARTIFICIAL NEURAL NETWORKS TECHNIQUES

<b>Course Code</b>	<b>24SJPECAT522</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To help the learners in recognizing and modelling complex patterns and relationships in data that might be challenging for traditional algorithms to handle.
2. To enable the students to create models that can predict future outcomes based on historical data, which is valuable in various domains such as finance, healthcare, and marketing.
3. To equip the learners to perform classification tasks in a better way, such as image and speech recognition, where they can categorize input data into predefined classes with high accuracy.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Artificial Neural Networks:</b> Human Brain, Model of an artificial Neuron, Basic concepts of Neural Networks, Fundamentals of Biological Neural Network and Artificial Neural Network, Types of activation functions, Applications of Neural Networks. <b>Learning Methods</b> - Supervised, Unsupervised and reinforcement, Taxonomy of Neural Network Architectures, Terminologies – weights, bias, threshold, learning rate, Applications of Neural Networks.	<b>8</b>
<b>2</b>	<b>Basic of ANN Model :</b> McCulloch-Pitts Neuron, Architecture, Algorithm and Applications. Biases and Thresholds, Linear Separability. Hebb Net - Algorithm, Applications. Perceptron - Architecture, Algorithm, Applications. Perceptron Learning Rule Convergence Theorem. Adaline - Architecture, Algorithm, Applications.	<b>9</b>
<b>3</b>	<b>Multilayer Perceptrons:</b> Multi-Layered network architecture, Back propagation Algorithm, Applications, XOR problem, Replacing and Modifying Back propagation Algorithms Using Heuristics.	<b>10</b>

	Cover's Theorem on the Separability of Patterns, The Interpolation Problem, Radial Basis Function Networks, Comparison of MLP and RBF Networks (Theory only).	
<b>4</b>	<b>SOMs and ART Networks</b> : Self-organizing maps - Building, Training, Evaluating, Interpreting and Visualizing a Self- organizing Map. Applications of Self Organizing Maps. Adaptive Resonance Theory -Stability Plasticity Dilemma, ART-1-Architecture, Algorithm, Applications. ART-2 – Architecture, Algorithms, Applications.	<b>9</b>

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

**Continuous Internal Evaluation Marks (CIE):**

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

**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*

<b>Part A</b>	<b>Part B</b>	<b>Total</b>
<ul style="list-style-type: none"> <li>● 2 Questions from each module.</li> <li>● Total of 8 Questions, each carrying 3 marks</li> </ul> <p align="center"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>● Each question carries 9 marks.</li> <li>● Two questions will be given from each module, out of which 1 question should be answered.</li> <li>● Each question can have a maximum of 3 subdivisions.</li> </ul> <p align="center"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

### Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain the basic concepts and the learning methods of ANN.	<b>K2</b>
<b>CO2</b>	Understand the fundamental learning algorithms namely, Mc-Culloch Pitts, Hebb Perceptron and Adaline to solve real world problems.	<b>K2</b>
<b>CO3</b>	Illustrate Back propagation learning algorithm, Generic Radial Basis Function network.	<b>K3</b>
<b>CO4</b>	Demonstrate Self Organizing Maps and Adaptive Resonance Theory.	<b>K2</b>

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
<b>CO1</b>	✓	✓									✓
<b>CO2</b>	✓	✓									✓
<b>CO3</b>	✓	✓									✓
<b>CO4</b>	✓	✓									✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
<b>1</b>	Artificial neural networks: An Introduction	Kevin L. Priddy, Paul E. Keller	SPIE Press	1/e, 2005
<b>2</b>	Neural networks, A Comprehensive Foundation	Simon Hykin	Pearson Education	2/e, 1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
<b>1</b>	Neural Networks – A classroom approach	Satish Kumar	Tata McGraw-Hill Publishing Company Limited	2/e, 2017

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Module No.</b>	<b>Link ID</b>
<b>1</b>	Introduction to Artificial Neural Networks <a href="https://nptel.ac.in/courses/117105084">https://nptel.ac.in/courses/117105084</a>
<b>2</b>	Deep Learning <a href="https://onlinecourses.nptel.ac.in/noc20_cs62/preview">https://onlinecourses.nptel.ac.in/noc20_cs62/preview</a>
<b>3</b>	Machine Learning And Deep Learning -- Fundamentals And Applications, IIT Guwahati- <a href="https://nptel.ac.in/courses/108103192">https://nptel.ac.in/courses/108103192</a>



## SEMESTER S5

### DATA ANALYTICS

<b>Course Code</b>	<b>24SJPECST523</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To help the learner to understand the basic concepts of data analytics.
2. To cover the mathematics for data analytics, predictive and descriptive analytics of data, classification, clustering and text analytics
3. To enable the learners to perform data analysis on a real-world scenario using appropriate tools.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction to Data Analytics:</b> Analytics process Model, Analytical Model Requirements, Data Analytics Life Cycle Overview: Probability Calculus-Probability Distributions: Hypothesis Testing-Basic definitions Proximity Measures-Data Objects, Attribute types, Dissimilarity and Similarity Measures.	<b>8</b>
<b>2</b>	<b>Association of Two Variables: -</b> Summarizing the distribution of Two Discrete variables, Contingency tables for Discrete data, Joint, Marginal and Conditional Frequency Distributions, Graphical Representation of two nominal or ordinal variables, Measures of Association for Two Discrete variables, Association between ordinal and continuous variables, Visualization of variables from different scales.	<b>9</b>
<b>3</b>	<b>Statistical Description of data:</b> -Central tendency, Dispersion Range, Quartiles, Variance, Standard Deviation and Interquartile Range. Data Preprocessing Cleaning, Integration, Reduction, Transformation, Discretization. <b>Mining Frequent Patterns:</b> Associations, Co-relations and Apriori Algorithms. <b>Classification:</b> General Approach to classification, ID3, Attribute selection measures, Naïve Bayesian Classification. <b>Clustering-KMeans, Agglomerative versus Divisive Hierarchical Clustering, BIRCH, DBSCAN</b>	<b>9</b>

<b>4</b>	<b>Text Processing: -</b> Boolean retrieval, Example IR Problem, inverted index, processing Boolean queries, tokenization, stemming, phrase queries, vector space model, finite automata and language model, query likelihood model, naïve bayes text classification.	<b>9</b>
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**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
<ul style="list-style-type: none"> <li>2 Questions from each module.</li> <li>Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>Each question carries 9 marks.</li> <li>Two questions will be given from each module, out of which 1 question should be answered.</li> <li>Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

**Course Outcomes (COs)**

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain the key concepts of Data Analytics	<b>K2</b>
<b>CO2</b>	Apply appropriate techniques to convert raw data into suitable format for practical data analytics tasks	<b>K3</b>
<b>CO3</b>	Extend the concept of association rule mining in real world scenario	<b>K3</b>
<b>CO4</b>	Select appropriate clustering and classification algorithms for various application and extend data analytics methods to new domains of data.	<b>K4</b>
<b>CO5</b>	Understand the basics of text analytics and text classification.	<b>K3</b>

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

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓			✓				✓		✓
CO2	✓	✓		✓	✓				✓		✓
CO3	✓	✓	✓	✓	✓				✓		✓
CO4	✓	✓	✓	✓	✓				✓		✓
CO5	✓	✓	✓	✓	✓				✓		✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Statistics and Data Analysis	Christin Heumann and Michael Schomaker	Springer	1/e,2016
2	Datamining Concepts and Techniques	Jiawei Han and Micheline Kamber	Springer	3/e, 2012

Reference Book				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to information Retrieval	Christopher D Manning, Raghavan, P Schutze.H	Cambridge University Press	1/e,2008
2	Mining Text Data	Charu C Aggarwal, Cheng Xiang Zhai	Springer	1/e,2012
3	Analytics in a Big Data World: The Essential Guide to Data Science and in Business Intelligence and Analytic Trends	Bart Basens	John Wiley	1/e,2013
4	Introduction in Data Mining	Pang -Ning Tan, Michael Steinbach and Vipin Kumar	Pearson Education	1/e,2007

No.	Link ID
1	<a href="https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs15/">https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs15/</a>
2	<a href="https://onlinecourses.swayam2.ac.in/cec19_cs01/preview">https://onlinecourses.swayam2.ac.in/cec19_cs01/preview</a>

## SEMESTER 5

### DIGITAL SIGNAL PROCESSING

(Common to CS/CA)

<b>Course Code</b>	<b>24SJPECST526</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	24SJPECST416	<b>Course Type</b>	Theory

#### Course Objectives:

1. To teach the concept of DFT and apply it for filtering data sequences.
2. To educate on the algorithms for complexity reduction in the computation of DFT.
3. To teach the theory of FIR and IIR filters and to design FIR filters.
4. To get exposed to the basic idea of some of the important techniques for designing efficient VLSI architectures for DSP.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Definition of a digital signal processing system, Sampling, Sampling rate, DFT and IDFT (Properties of DFT). Linear Convolution using Circular Convolution, Convolution of long data sequences- Overlap add method, overlap save method. Linear filtering methods based on DFT – FFT (DIT- FFT only) – efficient computation of the DFT of a $2N$ point real sequences – correlation – use of FFT in linear filtering and correlation, Symmetries in the DFT	<b>9</b>
<b>2</b>	Types of transfer functions- Ideal filters, Zero phase and linear phase transfer functions, Types of linear phase FIR transfer functions; Simple digital filters: Simple FIR digital filters (Low pass and high pass), Simple IIR digital filters (Low pass and high pass), All pass and minimum phase transfer function Design of FIR filter : window based design (Rectangular, Hamming, Hanning windows). Applications of DSP-Spectral analysis of sinusoidal signals.	<b>8</b>

3	Realization structures for FIR filters- direct, cascade, parallel. IIR Filter realization structures (Direct form I, II, cascade and Parallel and transposed structures); Computational accuracy in DSP implementation- Number formats for signals and coefficients in DSP systems, Dynamic range and precision, Sources of error in DSP implementation - A/D conversion error, DSP computational error, D/A Conversion error.	9
4	<p>FFT and FIR Filter realization on a fixed point processor -finite word length effects - Quantization, rounding and truncation, overflow and scaling. DSP Algorithm representations, data flow, control flow, signal flow graphs, block diagrams - Loop bound, iteration bound, critical path - Pipelining, parallel processing, low power architectures - Retiming, folding and unfolding techniques, applications.</p> <p><b>Hands-on :</b> -</p> <ul style="list-style-type: none"> <li>• FPGA based hardware realization of the FFT algorithm, circular convolution, IIR and FIR filter structures using iVerilog.</li> <li>• To realize different DSP algorithms including basic multiply accumulation and shifting operations on a fixed point processor.</li> <li>• Analyze the effect of the finite word length by implementing the FFT algorithm and FIR filters by using fixed point coefficient representation in different formats like Q7, Q15 etc.</li> <li>• Design an FIR low pass filter using MATLAB/SCILAB and check how it filters a speech signal by recording it and playing the result.</li> </ul>	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
<ul style="list-style-type: none"> <li>2 Questions from each module.</li> <li>Total of 8 Questions, each carrying 3 marks</li> </ul> <p>(8x3 =24 Marks)</p>	<ul style="list-style-type: none"> <li>Each question carries 9 marks.</li> <li>Two questions will be given from each module, out of which 1 question should be answered.</li> <li>Each question can have a maximum of 3 subdivisions.</li> </ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

### Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Understand the concept of DFT and apply it for determining the spectral information of data sequences.	<b>K2</b>
<b>CO2</b>	Apply algorithms for complexity reduction in the computation of DFT.	<b>K3</b>
<b>CO3</b>	Use the theory of FIR and IIR filters and be able to design FIR filters using the window method.	<b>K3</b>
<b>CO4</b>	Build the IIR and FIR filter transfer functions using suitable structures	<b>K3</b>
<b>CO5</b>	Identify the effect of finite word length on DSP algorithm implementation	<b>K3</b>
<b>CO6</b>	Utilize the low power architectures for implementing the DSP algorithms	<b>K3</b>

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
<b>CO1</b>	✓	✓	✓								✓
<b>CO2</b>	✓	✓	✓								✓
<b>CO3</b>	✓	✓	✓	✓							✓
<b>CO4</b>	✓	✓	✓	✓							✓
<b>CO5</b>	✓	✓	✓	✓							✓
<b>CO6</b>	✓	✓	✓				✓				✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Signal Processing [Modules 1,2,3]	S. Salivahanan	McGraw Hill	10/e, 2019
2	Digital Signal Processing: A Computer - Based Approach [Modules 2]	Sanjit K.Mitra	McGraw Hill	4/e, 2013
3	VLSI Signal Processing Systems, Design and Implementation [Module 4]	Keshab K. Parhi	Wiley	1/e, 2007

<b>Reference Books</b>				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Signal Processing	John G. Prokakis, Dimitris K Manolakis	Pearson	4/e, 2007
2	Introduction to Digital Signal Processing	Johnny R Johnson	Pearson	1/e, 2015
3	Mathematics of the Discrete Fourier Transform (DFT): with Audio Applications	Julius O. Smith III	W3K Publishing	2/e, 2007
4	Digital Signal Processing : Fundamentals, Techniques and Applications	Juan Zhang	Nova Science Publishers	1/e, 2016
5	Fast Fourier Transform Algorithms for Parallel Computers (Vol 2)	Daisuke Takahashi	Springer	1/e,

<b>Video Links (NPTEL, SWAYAM...)</b>	
No.	Link ID
1	<a href="https://archive.nptel.ac.in/courses/108/101/108101174/">https://archive.nptel.ac.in/courses/108/101/108101174/</a>
2	<a href="https://methodist.edu.in/web/uploads/files/DSP%20NOTES.pdf">https://methodist.edu.in/web/uploads/files/DSP%20NOTES.pdf</a>

## SEMESTER 5

### COMPUTER GRAPHICS & MULTIMEDIA

(Common to CS/CA/AD)

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

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Basics of Computer graphics</b> - 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. <b>Line and Circle drawing Algorithms</b> - Line drawing algorithms- Bresenham's algorithm, Liang-Barsky Algorithm, Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's Circle drawing algorithm.	<b>10</b>
<b>2</b>	<b>Geometric transformations</b> - 2D and 3D basic transformations - Translation, Rotation, Scaling, Reflection and Shearing, Matrix representations and homogeneous coordinates. <b>Filled Area Primitives</b> - Scan line polygon filling, Boundary filling and flood filling.	<b>8</b>
<b>3</b>	<b>Transformations and Clipping Algorithms</b> - Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms. <b>Three-dimensional graphics</b> - 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.	<b>8</b>

<b>4</b>	<p><b>Fundamental of Multimedia</b> - 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.</p> <p><b>Compression Methods</b> - 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.</p>	<b>9</b>
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### 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
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

#### 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
<ul style="list-style-type: none"> <li>● 2 Questions from each module.</li> <li>● Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>● Each question carries 9 marks.</li> <li>● Two questions will be given from each module, out of which 1 question should be answered.</li> <li>● Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

## Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Understand the principles of computer graphics and displays	<b>K2</b>
<b>CO2</b>	Illustrate line drawing, circle drawing and polygon filling algorithms	<b>K3</b>
<b>CO3</b>	Illustrate 2D and 3D basic transformations and matrix representation	<b>K3</b>
<b>CO4</b>	Demonstrate different clipping algorithms and 3D viewing pipeline.	<b>K3</b>
<b>CO5</b>	Summarize the multimedia features and specific compression algorithms	<b>K2</b>

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
<b>CO1</b>	✓	✓	✓								✓
<b>CO2</b>	✓	✓	✓	✓							✓
<b>CO3</b>	✓	✓	✓	✓							✓
<b>CO4</b>	✓	✓	✓	✓							✓
<b>CO5</b>	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

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

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
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

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Module No.</b>	<b>Link ID</b>
<b>1, 2, 3</b>	Computer Graphics By Prof. Samit Bhattacharya at IIT Guwahati <a href="https://onlinecourses.nptel.ac.in/noc20_cs90/preview">https://onlinecourses.nptel.ac.in/noc20_cs90/preview</a>
<b>4</b>	Web Based Technologies and Multimedia Applications by Prof. P. V. Suresh at Indira Gandhi National Open University <a href="https://onlinecourses.swayam2.ac.in/nou20_cs05/preview">https://onlinecourses.swayam2.ac.in/nou20_cs05/preview</a>

## SEMESTER 5

### ADVANCED COMPUTER ARCHITECTURES

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

#### Course Objectives:

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

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
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 – the need for bench mark to compare performance , Desktop and Server Amdahl’s Law, Processor Performance Equation-	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 branch predictor Dynamic Scheduling – Idea, Introduction to Tomasulo’s scheme. Register Renaming Hardware Speculation, Reorder Buffers Multiple issue and static scheduling, VLIW –	9
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 Primitives. Memory Consistency Models – Sequential and relaxed -	12

	introduction to NUMA	
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]	12

### 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
<ul style="list-style-type: none"> <li>2 Questions from each module.</li> <li>Total of 8 Questions, each carrying 3 marks</li> </ul> <p><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>Each question carries 9 marks.</li> <li>Two questions will be given from each module, out of which 1 question should be answered.</li> <li>Each question can have a maximum of 3 subdivisions.</li> </ul> <p><b>(4x9 = 36 marks)</b></p>	<b>60</b>

## 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.	K2
CO2	Compute the effect of hardware/software enhancements on the speedup of a processor using Amdahl's law.	K3
CO3	Interpret possible dependencies that can cause hazards in a given block of code.	K3
CO4	Summarize different strategies followed to ensure Instruction Level Parallelism.	K2
CO5	Compare different strategies followed to ensure Instruction Level Parallelism and different strategies followed to ensure Data Parallelism.	K3
CO6	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)

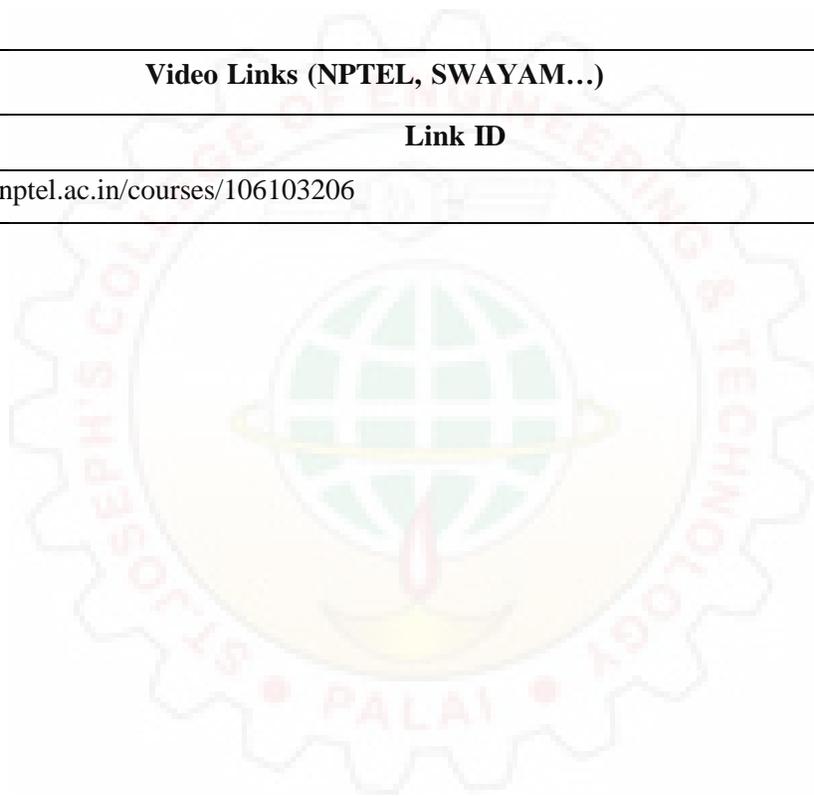
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓								✓
CO3	✓	✓	✓								✓
CO4	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓							✓
CO6	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

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

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
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

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>No.</b>	<b>Link ID</b>
1	<a href="https://nptel.ac.in/courses/106103206">https://nptel.ac.in/courses/106103206</a>



## SEMESTER 5

### DATA MINING

(Common to CS/CA)

<b>Course Code</b>	<b>24SJPECST525</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:1	<b>ESE Marks</b>	60
<b>Credits</b>	5/3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To provide a thorough understanding of the key processes and concepts involved in data mining and data warehousing within application domains.
2. To enable students to understand the different data pre-processing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, text mining and web mining, and apply these techniques in real-world scenarios

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
1	<b>Data Mining Fundamentals: -</b> Data Mining - concepts and applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities Data warehouse - Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture.	8
2	<b>Data Preprocessing: -</b> Data Preprocessing - Need of data preprocessing, Data Cleaning- Missing values, Noisy data, Data Integration and Transformation. Data Reduction - Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation.	9
3	<b>Classification And Clustering: -</b> Classification - Introduction, Decision tree construction principle, Information Gain, Gini index, Decision tree construction algorithm - ID3, Neural networks, back propagation, Rule-Based Algorithms - Generating Rules from a DT, Generating Rules from a Neural Net. Clustering - Introduction to clustering, distance measures, Clustering Paradigms, Partitioning Algorithm - k means, Hierarchical Clustering, DBSCAN	9

<b>4</b>	<b>Association Rule Analysis and Advanced Data Mining: -</b> Association Rule Mining - Concepts, Apriori algorithm, FP Growth Algorithm. Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Web Usage Mining- Preprocessing, Data structures, Pattern Discovery, Pattern Analysis. Spatial Mining - Spatial Queries, Spatial Data Structures, Thematic Maps, Image Databases.	<b>10</b>
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**Criteria for Evaluation (Evaluate and Analyse): 20 marks**

Students must be asked to identify problems involving large datasets and identify the right solution from the concepts already learned. A comparison of the results with a similar approach also needs to be performed to assess the Knowledge Level 5.

**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
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks <b>(8x3 =24 marks)</b></li> </ul>	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.  <b>(4x9 = 36 marks)</b>	<b>60</b>

## Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the key process of data mining and data warehousing concepts in application domains.	K2
CO2	Apply appropriate pre-processing techniques to convert raw data into suitable format for practical data mining tasks	K3
CO3	Illustrate the use of classification and clustering algorithms in various application domains	K3
CO4	Comprehend the use of association rule mining techniques	K3
CO5	Explain advanced data mining concepts and their applications in emerging domains	K2

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	✓	✓									✓
CO2	✓	✓	✓	✓	✓						✓
CO3	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓	✓						✓
CO5	✓	✓									✓

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	JaiweiHan, Micheline Kamber	Elsevier	3/e, 2006
2	Data Mining: Introductory and Advanced Topics	Dunham M H	Pearson Education	1/e, 2006

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Data Mining	Pang-Ning Tan, Michael Steinbach	Addison Wesley	1/e, 2014
2	Data Mining: Concepts, Models, Methods, and Algorithms	Mehmed Kantardzic	Wiley	2/e, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	<a href="https://youtu.be/ykZ-_UGcYWg?si=qiqynQyjI1sNNiHE">https://youtu.be/ykZ-_UGcYWg?si=qiqynQyjI1sNNiHE</a>
2	<a href="https://youtu.be/NSxEiohAH5o?si=ZIJHMiRvpFcNQNMA">https://youtu.be/NSxEiohAH5o?si=ZIJHMiRvpFcNQNMA</a>
3	<a href="https://youtu.be/VsYKqOokgaE?si=rgndBZqpzB29LUGg">https://youtu.be/VsYKqOokgaE?si=rgndBZqpzB29LUGg</a>
4	<a href="https://youtu.be/N_whCVtfL9M?si=VPMH9NP4vdAaiuPe">https://youtu.be/N_whCVtfL9M?si=VPMH9NP4vdAaiuPe</a>

## SEMESTER S5

### FOUNDATIONS OF SECURITY IN COMPUTING

<b>Course Code</b>	<b>24SJPECAT529</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:1	<b>ESE Marks</b>	60
<b>Credits</b>	5/3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	none	<b>Course Type</b>	Theory

#### Course Objectives:

1. To provide the fundamental security principles including cryptography, authentication, and access control.
2. To enable the learners to Identify and mitigate threats and vulnerabilities in software, networks, and operating systems.
3. To provide practical skills in securing computing systems and managing security policies and incidents.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Modular Arithmetic:-</b> Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm. <b>Prime Numbers and Factorization:-</b> Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications. Factorization - Fermat's factorization, Pollard p-1 method.	<b>9</b>
<b>2</b>	<b>Symmetric Cipher Models:-</b> Substitution techniques - Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Cipher, One Time Pad. Transposition techniques, Block Cipher principles- The Data Encryption Standard(DES), Strength of DES, Block Cipher Operation- Electronic Code Book, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode. Advanced Encryption Standard (AES)- Basic Structure, Transformation Functions, Key Expansion.	<b>9</b>
<b>3</b>	<b>Public key Cryptography:</b> - Principles of Public Key Cryptosystems, RSA Algorithms- Description of the Algorithm, Computational Aspects, The security of RSA, Diffie-Hellman Key Exchange Algorithm, Key Exchange Protocols, Man-in-the-Middle Attack, Elliptic Curve Cryptography-Analog of Diffie-Hellman Key Exchange, Elliptic Curve Encryption/Decryption, Security of Elliptic Curve Cryptography.	<b>9</b>

<b>4</b>	<p><b>Operating system security:</b> – security in the operating system, Security in the design of the operating system.</p> <p><b>Database security:</b> – Security requirements of databases, Reliability, and integrity, Database disclosure.</p> <p><b>Cloud Security:</b> Cloud Computing Concepts, Moving to the Cloud, Cloud Security Tools and Techniques, Cloud Identity Management.</p>	<b>9</b>
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**Course Assessment Method**  
(CIE: 40 marks, ESE: 60 marks)

**Continuous Internal Evaluation Marks (CIE):**

<i>Attendance</i>	<i>Internal Exam</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

**Criteria for Evaluation (Evaluate and Analyse): 20 marks**

Do a project based on the algorithms studied and analyse the performance of the algorithms

**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*

<b>Part A</b>	<b>Part B</b>	<b>Total</b>
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks <b>(8x3 =24 marks)</b></li> </ul>	<ul style="list-style-type: none"> <li>• 2 questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 subdivisions.</li> <li>• Each question carries 9 marks. <b>(4x9 = 36 marks)</b></li> </ul>	<b>60</b>

## Course Outcomes (COs)

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

Course Outcomes		Bloom's Knowledge Level (KL)
CO1	Apply concepts of modular arithmetic, including integer division, divisibility, GCD, and prime numbers, along with mathematical concepts related to factorization methods such as Fermat's and Pollard's methods, to solve cryptographic problems.	K3
CO2	Assess various symmetric cipher models, including substitution and transposition techniques, as well as block ciphers. and AES.	K3
CO3	Apply the principles of public key cryptography and evaluate their security aspects.	K3
CO4	Model the security requirements in operating systems and databases, and analyze cloud security concepts, tools, and identity management techniques.	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	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography and Network Security Principles and Practice	William Stallings	Pearson Ed.	4/E,2005
2	Cryptography and Network Security	Behrouz A Forouzan	Tata McGraw-Hill.	3/E,2015

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Elementary Number Theory	G.A. Jones & J.M. Jones	Springer UTM	1/E, 2007
2	The Complete Reference: Information Security	Mark Rhodes-Ousley	McGraw-Hill	2/E,2012
3	Principles of Computer Security: CompTIA Security+ and Beyond	Wm.Arthur Conklin, Greg White	McGraw-Hill	2/E,2011

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Module No.</b>	<b>Link ID</b>
1	<a href="https://youtu.be/ZMDTndFMgks?si=c0ZpKrBTGljcD6Zy">https://youtu.be/ZMDTndFMgks?si=c0ZpKrBTGljcD6Zy</a> <a href="https://youtu.be/XBnUWjo3TgM?si=hZz0EsUeQd3XV_lu">https://youtu.be/XBnUWjo3TgM?si=hZz0EsUeQd3XV_lu</a>
2	<a href="https://youtu.be/QbczPuEphUY?si=4SuxgwFAAarvfN5x">https://youtu.be/QbczPuEphUY?si=4SuxgwFAAarvfN5x</a>
3	<a href="https://youtu.be/7eI4YTjqO30?si=bn9tKAWuifgRae7I">https://youtu.be/7eI4YTjqO30?si=bn9tKAWuifgRae7I</a>
4	<a href="https://youtu.be/i_7ofp7fK_E?si=qYAkK4YtqgXrKJ1S">https://youtu.be/i_7ofp7fK_E?si=qYAkK4YtqgXrKJ1S</a> <a href="https://youtu.be/q_4VErC7bwA?si=6qfVdNHjYWYGnsru">https://youtu.be/q_4VErC7bwA?si=6qfVdNHjYWYGnsru</a>



## SEMESTER 6

### NATURAL LANGUAGE PROCESSING

<b>Course Code</b>	<b>24SJPCCAT601</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L:T:P: R)</b>	3:1:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	4	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To provide a comprehensive understanding of natural language processing (NLP) and language models, focusing on the principles and techniques of prompt engineering to effectively guide and optimize AI-driven outputs.
2. practical skills necessary to design, implement, and evaluate prompt engineering strategies across various applications, while considering the ethical implications and challenges associated with AI-generated content.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction to NLP:</b> Introduction to Natural Language Processing - Various stages of traditional NLP – Challenges - Basic Text Processing techniques - Common NLP Tasks. N-gram Language Models - Naive Bayes for Text Classification, and Sentiment Analysis – Evaluation-Precision, Recall and F-measure-Test sets and cross validation.	<b>8</b>
<b>2</b>	<b>Traditional NLP Techniques:</b> Annotating Linguistic Structures - Context-Free Grammars, Constituency Parsing, Ambiguity, Dependency Parsing - Transition-Based Dependency Parsing, Graph-Based Dependency Parsing, Evaluation.	<b>8</b>
<b>3</b>	<b>Neural Networks for NLP:</b> Word representations - Lexical Semantics, Vector Semantics, TF-IDF, Neural Word embeddings - Word2vec, GloVe, Contextual Word Embeddings. Evaluating Vector Models - Feedforward Neural Networks for Text Classification	<b>10</b>

<b>4</b>	<p><b>Advanced NLP and Applications:</b></p> <p>Sequence Modelling - Recurrent Neural Networks, RNNs as Language Models, RNNs for NLP tasks, Bidirectional RNN architectures, Recursive Neural Networks, LSTM &amp; GRU, Common RNN NLP Architectures, Encoder-Decoder Model with RNNs, Attention models, Transformers, BERT, GPT, NLP Applications - Machine Translation, Question Answering and Information Retrieval, Introduction to Large Language Models.</p>	<b>16</b>
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**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
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

**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
<ul style="list-style-type: none"> <li>● 2 Questions from each module.</li> <li>● Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>● Each question carries 9 marks.</li> <li>● Two questions will be given from each module, out of which 1 question should be answered.</li> <li>● Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

### Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Understand the foundational concepts of NLP and apply that to do text processing.	<b>K3</b>
<b>CO2</b>	Apply and implement advanced linguistic annotation and parsing techniques	<b>K3</b>
<b>CO3</b>	Utilize word representations and evaluate vector models for NLP	<b>K3</b>
<b>CO4</b>	Apply advanced sequence modeling techniques using Neural Networks and NLP techniques in machine translation, question answering, and information retrieval.	<b>K3</b>

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

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

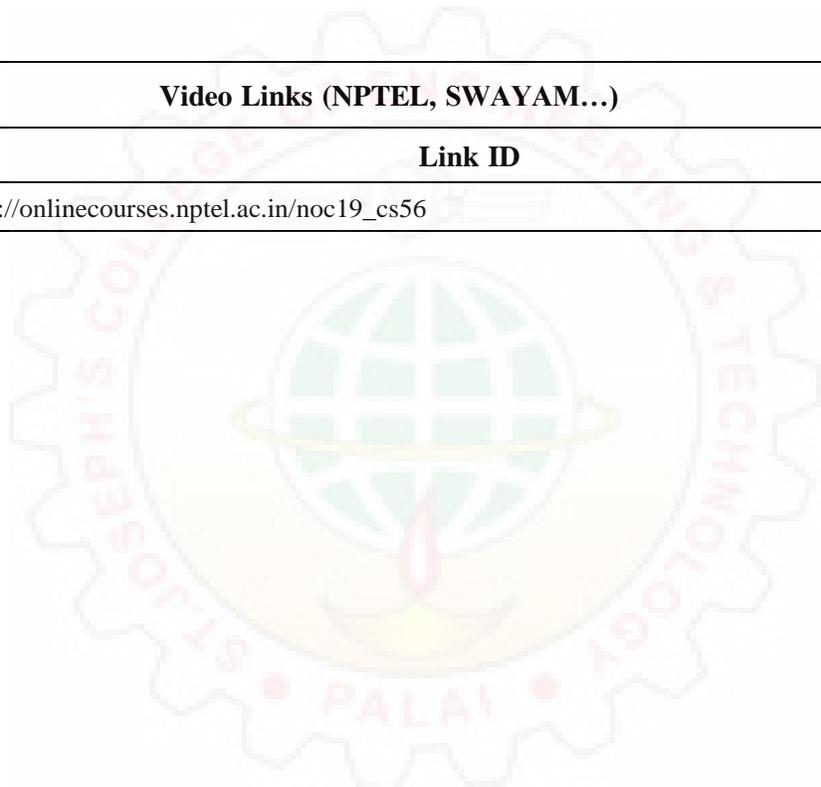
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
<b>CO1</b>	✓	✓									✓
<b>CO2</b>	✓	✓			✓	✓					✓
<b>CO3</b>	✓	✓			✓						✓
<b>CO4</b>	✓	✓	✓		✓	✓					✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

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: An introduction to natural language processing, computational linguistics, and speech recognition	Dan Jurafsky and James H. Martin.	Pearson	2006
2	Introduction to Natural Language Processing	Jacob Eisenstein	MIT Press	2019
3	Natural Language Processing with Transformers	Lewis Tunstall, Leandro von Werra, and Thomas Wolf	O'Reilly	2022

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Deep learning for Natural Language Processing	Stephan Raaijmakers	Manning	2022
2	Natural Language Processing with PyTorch	Delip Rao and Brian McMahan	O'Reilly	2019
3	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT Press	2016
4	Transformer, BERT, and GPT: Including ChatGPT and Prompt Engineering (MLI Generative AI Series)	Oswald Campesato	Mercury Learning & Information	2023

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>No.</b>	<b>Link ID</b>
1	<a href="https://onlinecourses.nptel.ac.in/noc19_cs56">https://onlinecourses.nptel.ac.in/noc19_cs56</a>



## SEMESTER 6

### ROBOTICS AND AUTOMATION

<b>Course Code</b>	<b>24SJPCCAT602</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To enable to students to understand the characteristics of Robotics and the working of actuators and sensors in various scenarios
2. To teach how robots use various sensors to perceive their environment, techniques for preparing raw sensory data for analysis and methods for dividing an image into meaningful regions or objects to simplify analysis.
3. To make students understand the position and orientation of Roberts, its localization and various challenges during localization.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction to robotics:-</b> 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.	<b>9</b>
<b>2</b>	<b>Sensors, Actuators and Control) Sensor classification:</b> 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.	<b>9</b>

<b>3</b>	<p><b>Robotic Vision:</b> 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.</p>	<b>9</b>
<b>4</b>	<p><b>Position and Orientation:</b> 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 for code reuse and sharing - Control localization</p>	<b>9</b>

**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
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

## 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
<ul style="list-style-type: none"> <li>2 Questions from each module.</li> <li>Total of 8 Questions, each carrying 3 marks</li> </ul> <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> <li>Each question carries 9 marks.</li> <li>Two questions will be given from each module, out of which 1 question should be answered.</li> <li>Each question can have a maximum of 3 subdivisions.</li> </ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

## Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain the concepts of manipulator and mobile robotics.	<b>K2</b>
<b>CO2</b>	Choose the suitable sensors, actuators and control for robot design	<b>K3</b>
<b>CO3</b>	Developing kinematic models of mobile robots and understanding robotic vision intelligence.	<b>K3</b>
<b>CO4</b>	Apply the localization and mapping methods in robotics.	<b>K3</b>
<b>CO5</b>	Plan the path and navigation of the robot by applying an artificial intelligence algorithm.	<b>K3</b>

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
<b>CO1</b>	✓	✓	✓								✓
<b>CO2</b>	✓	✓	✓								✓
<b>CO3</b>	✓	✓	✓								✓
<b>CO4</b>	✓	✓	✓								✓
<b>CO5</b>	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Introduction to Autonomous Mobile Robots	R Siegwart, IR Nourbakhsh, D Scaramuzza	MIT Press, USA	2/e, 2011
2	Embedded Robotics, Mobile Robot Design and Applications with Embedded Systems	Thomas Bräunl	Springer	2/e, 2006
3	Introduction to Mobile Robot Control	S.G. Tzafestas	Elsevier	1/e, 2014
4	Artificial Intelligence for Robotics	Francis X. Govers	Packt Publishing	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 Education	2/e, 2017

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

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Module No.</b>	<b>Link ID</b>
1, 2, 3, 4	<a href="https://onlinecourses.nptel.ac.in/noc21_me76/preview">https://onlinecourses.nptel.ac.in/noc21_me76/preview</a> <a href="https://nptel.ac.in/courses/107106090">https://nptel.ac.in/courses/107106090</a> <a href="https://onlinecourses.nptel.ac.in/noc23_me143/preview">https://onlinecourses.nptel.ac.in/noc23_me143/preview</a>

## SEMESTER 6

### INTRODUCTION TO DEEP LEARNING

<b>Course Code</b>	<b>24SJPBCAT604</b>	<b>CIE Marks</b>	60
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:1	<b>ESE Marks</b>	40
<b>Credits</b>	4	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	24SJPCST503	<b>Course Type</b>	Theory

#### Course Objectives:

1. To teach the basics of neural networks along with advanced topics, including recurrent neural networks, long short-term memory cells, and convolutional neural networks.
2. To enable the students to complete programming solutions for real world problems.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Neural Networks Introduction to Human and Artificial Intelligence:</b> History of AI, Forms of learning - Supervised and unsupervised learning, Perceptron Learning rule, Bio-inspired learning, Artificial Neural Networks, Backpropagation, Multi-layer Perceptron model, Activation Functions Loss functions, Optimization, Training Neural Networks - weight initialization, batch normalization, hyper parameter optimization, parameter updates, model ensembles	<b>8</b>
<b>2</b>	<b>Overview of deep learning:</b> deep feedforward networks, and training deep models, including optimization techniques such as Gradient Descent (GD), GD with momentum, Stochastic GD, AdaGrad, RMSProp, and Adam. Regularization methods - L1 and L2, early stopping, dataset augmentation, parameter sharing and tying, input noise injection, ensemble methods, dropout, and parameter initialization.	<b>12</b>
<b>3</b>	<b>Convolutional Neural Networks:</b> convolution layer, pooling layer, fully connected layer, Conv Net, Case study of ImageNet challenge: LeNet, AlexNet, VGG, Google Net, ResNet, Inception Net, Efficient Net etc. Regularization Techniques, Data Augmentation: zooming, rotation, cropping, blurring, noise addition, self-supervision techniques, semi-supervised and weakly supervised learning, adversarial training Transfer Learning, freezing the input layers, fine tuning output layers. RNNs: LSTM, GRU	<b>14</b>

<b>4</b>	<b>Deep Unsupervised Learning and Recent Trends:</b> Auto encoders (standard, sparse, denoising, contractive, etc.), Variational Autoencoders, Adversarial Generative Adversarial Networks, Auto encoder and DBM, Multi- task Deep Learning, Multi-view Deep Learning	<b>10</b>
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**Suggestion on Project Topics**

- Applications of Deep Learning to Computer Vision
- Applications of Deep Learning to NLP

**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
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 2 marks <b>(8x2 =16 marks)</b></li> </ul>	<ul style="list-style-type: none"> <li>• 2 questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 2 subdivisions.</li> <li>• Each question carries 6 marks. <b>(4x6 = 24 marks)</b></li> </ul>	<b>40</b>

## Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain the fundamental principles of neural networks and discuss the practical challenges associated with them.	<b>K2</b>
<b>CO2</b>	Explain the common regularization and optimization methods used in deep neural networks	<b>K2</b>
<b>CO3</b>	Use Deep Neural Networks with Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) for tasks such as object detection, image segmentation, and text-related issues.	<b>K3</b>
<b>CO4</b>	Determine which deep learning algorithms are best suited for different types of learning tasks across various domains.	<b>K3</b>
<b>CO5</b>	Implement deep learning algorithms and solve real-world problems.	<b>K3</b>

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
<b>CO1</b>	✓	✓									✓
<b>CO2</b>	✓	✓									✓
<b>CO3</b>	✓	✓	✓								✓
<b>CO4</b>	✓	✓	✓								✓
<b>CO5</b>	✓	✓	✓		✓						✓

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Deep Learning	Ian Good fellow and Yoshua Bengio and Aaron Courville	MIT Press	1/e, 2016
2	Neural networks and deep learning - Vol 2	Nielsen, Michael A	Determination press	1/e, 2015
3	Pattern Recognition and Machine Learning	Bishop, C., M.	Springer	1/e, 2006
4	Deep Learning with Python	Francois Chollet	Manning Publications	2/e, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Neural Networks: A Classroom Approach	Satish Kumar	Tata McGraw-Hill Education	1/e, 2005
2	Artificial Neural Networks	Yegnanarayana, B	PHI Learning	1/e, 2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Fundamental principles of neural networks NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1
2	Overview of deep learning, deep feedforward networks NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1
3	Convolutional Neural Network NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1
4	Autoencoders NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1

### 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
<b>Total</b>		<b>30</b>

### 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

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

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Fundamentals of design thinking and product development:</b> 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-	<b>6</b>

	<p>understanding innovation landscape - patentability - understanding the economic landscape - Unique Selling Proposition (USP) - Repeatability and Manufacturability - Sustainability - Leveraging business models for comprehensive analysis</p>	
2	<p><b>Empathize:</b> 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.</p> <p><b>Define:</b> Methods of Define Phase: Storytelling, Critical items diagrams, Define success.</p>	6
3	<p><b>Ideation :</b> 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.</p> <p><b>Proof of Concept (PoC):</b> Setting objectives; Risk assessment; Technology scouting; Document and process management; Change management; Knowledge Capture; Validating PoC; Story telling in PoC presentation</p>	6
4	<p><b>Design:</b> 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.</p> <p><b>Prototyping:</b> 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.</p> <p><b>Pilot build:</b> 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.</p>	6

	<p><b>Experiential Innovation Platforms:</b> Hackathons and Ideathons - Definition, Features, Types, Benefits, Key Differences Between Hackathons and Ideathons</p> <p>(Reference: <a href="https://medium.com/@zettabyte_pte_ltd/whats-the-difference-between-a-hackathon-and-an-ideathon-263c37335847">https://medium.com/@zettabyte_pte_ltd/whats-the-difference-between-a-hackathon-and-an-ideathon-263c37335847</a>)</p>	
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**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
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 sub divisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

**Course Outcomes (COs)**

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

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

<b>CO2</b>	Ideate using divergent and convergent thinking to arrive at innovative ideas keeping in mind the sustainability, inclusivity, diversity and equity aspects.	<b>K5</b>
<b>CO3</b>	Engage in Human Centric Design of innovative products meeting the specifications	<b>K5</b>
<b>CO4</b>	Develop Proof of Concepts (PoC), prototypes & pilot build of products and test their performance with respect to the Specification Requirement Document.	<b>K4</b>
<b>CO5</b>	Reflect on professional and personal growth through the learnings in the course, identifying areas for further development	<b>K4</b>

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
<b>CO1</b>	3	2	2		2	3	3	2	2		3
<b>CO2</b>	3	2	3		2	3	3	2	2		3
<b>CO3</b>	3	2	3		2	3	2	2	2		3
<b>CO4</b>	3	2	2		3	3	2	2	2		3
<b>CO5</b>	3					3	2	2	2		3

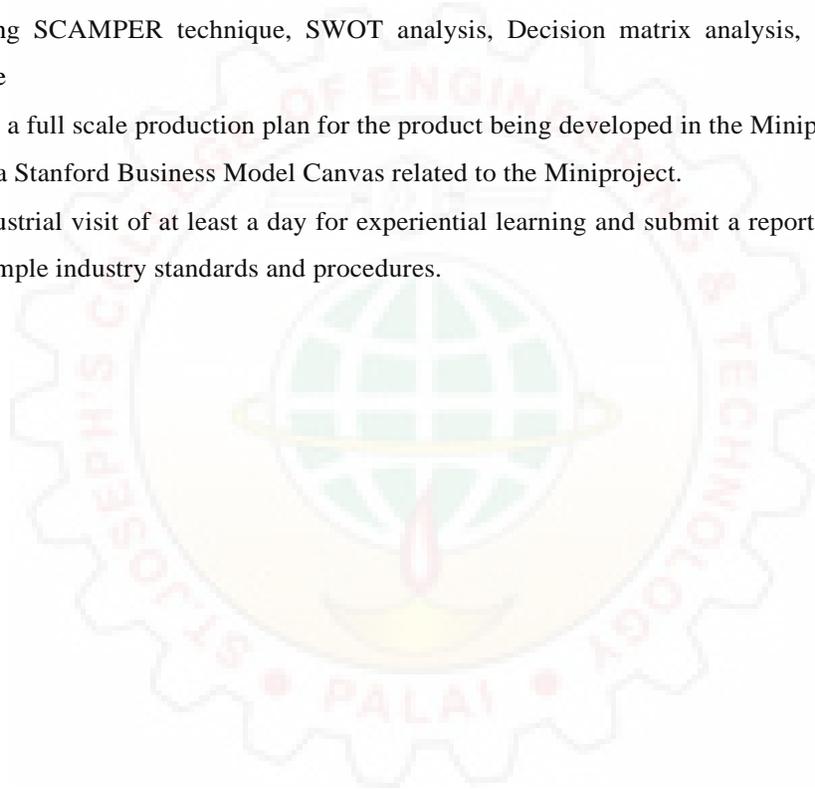
Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
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 6**  
**ROBOTICS LAB**

<b>Course Code</b>	<b>24SJPCCAL607</b>	<b>CIE Marks</b>	50
<b>Teaching Hours/Week (L: T:P: R)</b>	0:0:3:0	<b>ESE Marks</b>	50
<b>Credits</b>	2	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	PCCAL308	<b>Course Type</b>	Lab

**Course Objectives :**

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

*A minimum of ten experiments must be completed as part of the course requirements. (5 each from Part A & B)*

<b>Expt. No.</b>	<b>Experiments</b>
<b>PART A</b>	
<b>1</b>	Familiarisation of Arduino IDE, Arduino microcontroller I/O interfacing( LED, LCD, Serial Monitor)
<b>2</b>	Interfacing IR and Ultrasonic sensor with Arduino
<b>3</b>	Interfacing DC motors with arduino - speed and direction control
<b>4</b>	Interfacing Servo Motors with Arduino - angle of rotation
<b>5</b>	Familiarisation of Rasberry Pi and its I/O interfacing
<b>6</b>	Mobile Robot assembly
<b>7</b>	Networking with Arduino using BLE
<b>PART B</b>	
<b>8</b>	Writing a Simple Publisher and Subscriber, Simple Service and Client, Recording and playing back data, Reading messages from a bag file(Python/C++)
<b>9</b>	Localization of a mobile robot using LIDAR (ROS)
<b>10</b>	Implementing a weather station using Raspberry pi
<b>11</b>	Line following Robot using IR sensor
<b>12</b>	Image Recognition using ESP32 CAM module
<b>13</b>	Obstacle avoidance of a mobile robot while moving to a point.
<b>14</b>	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

*Note: 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.*

**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 Outcomes		Bloom's Knowledge Level (KL)
<b>CO1</b>	Interface different peripherals to Arduino and Raspberry Pi.	<b>K3</b>
<b>CO2</b>	Assemble a mobile robot with different sensors and actuators	<b>K3</b>
<b>CO3</b>	Implement localisation of mobile robots.	<b>K3</b>
<b>CO4</b>	Build intelligence in robots using standard algorithms.	<b>K3</b>
<b>CO5</b>	Implement Robot navigation.	<b>K3</b>

*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	✓	✓									✓
CO2	✓	✓									✓
CO3	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓	✓						✓

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Reference 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	2/e, 2017
3	Introduction to Robotics	John G Craig	Pearson	3/e, 2004
4	Introduction to Robotics	SK Saha	McGraw Hill	1/e, 2004
5	Robotics and Control	RK Mittal and I J Nagrath	Tata McGraw Hill	1/e, 2003
6	Robotic Tactile Sensing	Dahiya, Ravinder S., Valle, Maurizio	Springer	1/e, 2013

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1,2,3,4	<a href="https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/">https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/</a> <a href="https://onlinecourses.nptel.ac.in/noc21_me76/preview">https://onlinecourses.nptel.ac.in/noc21_me76/preview</a> <a href="https://nptel.ac.in/courses/107106090">https://nptel.ac.in/courses/107106090</a> <a href="https://onlinecourses.nptel.ac.in/noc23_me143/preview">https://onlinecourses.nptel.ac.in/noc23_me143/preview</a>

### 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 6**  
**MINI PROJECT**

<b>Course Code</b>	<b>24SJPCSP608</b>	<b>CIE Marks</b>	50
<b>Teaching Hours/Week (L: T:P: R)</b>	0:0:0:3	<b>ESE Marks</b>	50
<b>Credits</b>	2	<b>Exam Hours</b>	NA
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Project

**Preamble:** The objective of this course is to apply the fundamental concepts of Artificial Intelligence / Machine Learning 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 Outcomes:** After the completion of the course the student will be able to

<b>CO#</b>	<b>Course Outcomes</b>
<b>CO1</b>	Identify technically and economically feasible problems of social relevance ( <b>Cognitive Knowledge Level: Apply</b> )
<b>CO2</b>	Identify and survey the relevant literature for getting exposed to related solutions ( <b>Cognitive Knowledge Level: Apply</b> )
<b>CO3</b>	Perform requirement analysis and identify design methodologies and develop adaptable and reusable solutions of minimal complexity by using modern tools and advanced programming techniques ( <b>Cognitive Knowledge Level: Apply</b> )
<b>CO4</b>	Prepare technical report and deliver presentation ( <b>Cognitive Knowledge Level: Apply</b> )
<b>CO5</b>	Apply engineering and management principles to achieve the goal of the project ( <b>Cognitive Knowledge Level: Apply</b> )

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	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓			✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

### Split-up of Continuous Internal Evaluation : 50 Marks

Attendance	<b>05 marks</b>
Project Guide	<b>15 marks</b>
Project Report	<b>10 marks</b>
Evaluation by the Committee	<b>20 marks</b>
<b>Total</b>	<b>50 marks</b>

(Will be evaluating the level of completion and completion of Functionality /specifications, presentation, oral examination, work knowledge and involvement)

### Split-up of End Semester Examination: 50 Marks

The marks will be distributed as

Presentation	: 20 marks
Demonstration	: 20 marks
Viva	: 10 marks.
<b>Total</b>	<b>: 50 marks.</b>

### Course Plan

Student Groups with 3 or 4 members should identify a topic of interest (Socially relevant) in consultation with Project Coordinator/Guide. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carry out 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 30.

- 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 III

## SEMESTER S6

### SOFTWARE TESTING

(Common to CS/CA/AD)

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

#### Course Objectives:

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

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
1	<b>Introduction to Software Testing &amp; Automation:-</b> 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	<b>Unit Testing, Mutation Testing &amp; AI-Driven Automation:-</b> 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 generation and optimization; Industry Tools - Application of AI-driven testing tools in automation and predictive testing; Case Study - Mutation testing using JUnit, AI-enhanced test case automation.	8

<b>3</b>	<b>Advanced White Box Testing &amp; Security Testing:-</b> 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,; 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.	<b>10</b>
<b>4</b>	<b>Black Box Testing, Grey Box Testing, and Responsive Testing:-</b> 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.	<b>10</b>

**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
<ul style="list-style-type: none"> <li>● 2 Questions from each module.</li> <li>● Total of 8 Questions, each carrying 3 marks <b>(8x3 =24 marks)</b></li> </ul>	<ul style="list-style-type: none"> <li>● Each question carries 9 marks.</li> <li>● Two questions will be given from each module, out of which 1 question should be answered.</li> <li>● Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

## Course Outcomes (COs)

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

Course Outcomes		Bloom's Knowledge Level (KL)
<b>CO1</b>	Demonstrate the ability to apply a range of software testing techniques, including unit testing using JUnit and automation tools.	<b>K2</b>
<b>CO2</b>	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.	<b>K3</b>
<b>CO3</b>	Explain and apply graph coverage criteria in terms of control flow and data flow graphs to improve code quality.	<b>K2</b>
<b>CO4</b>	Demonstrate the importance of black-box approaches in terms of Domain and Functional Testing	<b>K3</b>
<b>CO5</b>	Illustrate the importance of security, compatibility, and performance testing across devices.	<b>K3</b>
<b>CO6</b>	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.	<b>K3</b>

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
<b>CO1</b>	✓	✓	✓		✓						✓
<b>CO2</b>	✓	✓	✓	✓	✓						✓
<b>CO3</b>	✓	✓	✓								✓
<b>CO4</b>	✓	✓	✓	✓							✓
<b>CO5</b>	✓	✓	✓		✓						✓
<b>CO6</b>	✓	✓	✓	✓	✓						✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

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

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
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

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Module No.</b>	<b>Link ID</b>
1	<a href="https://archive.nptel.ac.in/courses/106/101/106101163/">https://archive.nptel.ac.in/courses/106/101/106101163/</a>
2	<a href="https://archive.nptel.ac.in/courses/106/101/106101163/">https://archive.nptel.ac.in/courses/106/101/106101163/</a>
3	<a href="https://archive.nptel.ac.in/courses/106/101/106101163/">https://archive.nptel.ac.in/courses/106/101/106101163/</a>
4	<a href="https://archive.nptel.ac.in/courses/106/101/106101163/">https://archive.nptel.ac.in/courses/106/101/106101163/</a>
5	<a href="https://junit.org/">https://junit.org/</a>

## SEMESTER 6

### INTRODUCTION TO BUSINESS ANALYTICS

<b>Course Code</b>	24SJPECAT632	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To enable the students to use business analytics to formulate and solve business problems and to support managerial decision making.
2. To make the students familiarize the practices needed to develop, report, and analyze business data.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
1	<b>Introduction to Business Analytics:</b> Evolution, Scope, Models, Problem Solving with Analytics <b>Descriptive Analytics:</b> Data Visualization, Statistical methods for summarizing data – Frequency distribution for categorical and numerical data, Histogram, Cumulative relative frequency, Percentile and quartiles, Descriptive Statistical Measures- mean, median, mode, range, interquartile range, variance, standard deviation, correlation, covariance	10
2	<b>Probability Distributions:</b> Basic concepts of probability, Random Variables and Probability distribution, Discrete Probability distribution – binomial, Poisson, Continuous Probability Distribution – Uniform, Normal. Statistical Inference – Hypothesis testing procedure, Two-Tailed Test of Hypothesis for the Mean, Two-Sample Tests for Differences in Means	9
3	<b>Predictive:</b> Modelling relationships and trends in data, Simple Regression and Correlation: Introduction, Estimation using the regression line. Multiple Regression: The k-variable multiple regression model, The F-test of a Multiple Regression model.	9
4	<b>Prescriptive:</b> - Linear Programming Problem- Formulation, Graphical solutions, Simplex method, Revised Simplex method and Sensitivity Analysis; Transportation Problem- Formulation and solution; Assignment Problem- Formulation and solution	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
<ul style="list-style-type: none"> <li>2 Questions from each module.</li> <li>Total of 8 Questions, each carrying 3 marks</li> </ul> <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> <li>Each question carries 9 marks.</li> <li>Two questions will be given from each module, out of which 1 question should be answered.</li> <li>Each question can have a maximum of 3 subdivisions.</li> </ul> <p>(4x9 = 36 marks)</p>	60

**Course Outcomes (COs)**

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

Course Outcomes		Bloom's Knowledge Level (KL)
CO1	Apply statistical methods and data visualization techniques to explore, summarize, and interpret large datasets	K3
CO2	Apply probability and statistical inference to model business problems and assess risk.	K3
CO3	Build and evaluate predictive models using regression analysis and other statistical techniques to forecast trends, identify patterns, and support business planning.	K3
CO4	Formulate and solve optimization problems using linear programming and other quantitative methods	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
<b>CO1</b>	✓	✓	✓		✓						✓
<b>CO2</b>	✓	✓	✓		✓						✓
<b>CO3</b>	✓	✓	✓		✓						✓
<b>CO4</b>	✓	✓	✓		✓						✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Business Analytics	James R. Evans	Pearson Education Limited,	2/e, 2017

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Complete Business Statistics	Amir D. Aczel and J. Sounderpandian	Tata McGraw Hill	6/e, 2006
2	Operations Research: Applications and Algorithms	Wayne L. Winston	PWS-Kent Pub	4/e, 2004

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Module No.</b>	<b>Link ID</b>
1	Business Analytics For Management Decision <a href="https://onlinecourses.nptel.ac.in/noc20_mg11/preview">https://onlinecourses.nptel.ac.in/noc20_mg11/preview</a> Business Intelligence & Analytics <a href="https://onlinecourses.nptel.ac.in/noc24_cs65/preview">https://onlinecourses.nptel.ac.in/noc24_cs65/preview</a>
2	
3	
4	

## SEMESTER S6

### AI FOR CYBER SECURITY

<b>Course Code</b>	<b>24SJPECAT633</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>		<b>Course Type</b>	Theory

#### Course Objectives:

1. To explore AI techniques for enhancing cybersecurity.
2. To develop AI-based security solutions for threat detection and response.
3. To identify and mitigate AI-specific security risks and vulnerabilities.
4. To integrate AI tools with existing security infrastructure.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction to AI and Cybersecurity:-</b> Introduction to AI - Definition and types of AI (narrow AI vs. general AI)- Historical context and evolution of AI; Basics of Machine Learning - Supervised learning: regression and classification-Unsupervised learning: clustering and dimensionality reduction-Reinforcement learning: basics and applications; Key Concepts and Terminology - Algorithms, models, and training-Overfitting and underfitting; Applications of AI in Cybersecurity - Case Studies: Examples of AI in real-world cybersecurity applications; Benefits and Limitations	<b>8</b>
<b>2</b>	<b>AI Techniques for Security:-</b> Anomaly Detection - Techniques and Algorithms: Statistical methods for anomaly detection-Machine learning models: Isolation Forest, One-Class SVM, etc.; Threat Intelligence and Prediction-Data Collection and Processing - Gathering and preprocessing threat data-Feature extraction and engineering; Predictive Analytics - Building and evaluating predictive models for threat forecasting-Case studies on threat intelligence systems; Behavioral Analysis-Techniques - Behavioral profiling and pattern recognition-Analysing user and system behavior to detect anomalies	<b>9</b>
<b>3</b>	<b>Building AI Security Solutions :-</b> Designing Intrusion Detection Systems (IDS) - IDS types: network-based vs. host-based-Integrating AI techniques for enhanced detection; Automated Threat Response Mechanisms - Response strategies and automation workflows-Integration with threat detection systems; Integration with Existing Security Tools - Integration Techniques:-Connecting AI solutions with legacy security tools, Ensuring compatibility and effectiveness; Case Studies.	<b>10</b>

<b>4</b>	<b>Addressing AI Security Risks and Future Trends :-</b> AI Security Risks - Adversarial attacks: techniques and examples- Model poisoning and data privacy issues; Mitigating AI Security Risks; Strategies and Best Practices - Techniques for securing AI systems against adversarial attacks-Data protection and model validation strategies- Future Trends and Emerging Technologie - Emerging Technologies : Latest developments in AI and cybersecurity, Future directions and research areas, Impact of new technologies on cybersecurity.	<b>9</b>
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**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
<ul style="list-style-type: none"> <li>● 2 Questions from each module.</li> <li>● Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> <li>● Each question carries 9 marks.</li> <li>● Two questions will be given from each module, out of which 1 question should be answered.</li> <li>● Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;">(4x9 = 36 marks)</p>	<b>60</b>

**Course Outcomes (COs)**

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Identify the core AI concepts and machine learning techniques that can be used in cyber security	<b>K2</b>
<b>CO2</b>	Apply AI for threat detection and cybersecurity enhancements.	<b>K3</b>
<b>CO3</b>	Explain ethical and legal issues in using AI applications	<b>K2</b>
<b>CO4</b>	Apply AI-driven security tools and solutions for data security	<b>K3</b>

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	✓	✓									✓
CO2	✓	✓	✓								✓
CO3	✓	✓									✓
CO4	✓	✓	✓		✓						✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial Intelligence: A Guide for Thinking Humans	Melanie Mitchell	Penguin Books	1/e,2019
2	Introduction to Machine Learning with Python	Andreas C. Müller, Sarah Guido	O'Reilly Media	1/e, 2016
3	AI in Cybersecurity: Applications, Risks, and Challenges	Noura Al Moubayed, Pardeep Kumar	CRC Press	1/e, 2020
4	Ethics of Artificial Intelligence and Robotics	Vincent C. Müller	Springer	1/e,2020
5	Anomaly Detection for Monitoring Systems: A Practical Guide	David M. Hawkins	Wiley	1/e, 2019
6	Threat Intelligence: A Practical Guide	Michael L. Santarcangelo	Syngress	1/e, 2020

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 with Python	Andreas C. Müller, Sarah Guido	O'Reilly Media	1/e, 2016
2	Machine Learning Yearning	Andrew Ng	Self-Published	1/e, 2018
3	Adversarial Machine Learning	Ian Goodfellow, Jonathon Shlens, Christian Szegedy	MIT Press	1/e, 2021
4	Artificial Intelligence: The Next Generation	Ben Goertzel, Cassio Pennachin	Wiley	1/e, 2020
5	Behavioral Cybersecurity: The Psychology of Cybersecurity	Chris L. Bader, Patrick W. O'Leary	CRC Press	1/e, 2021
6	Intrusion Detection and Prevention Systems	S. V. Raghavan	CRC Press	1/e, 2017
7	Automated Cyber Defense: Concepts and Techniques	Chris Eagle	CRC Press	1/e, 2019
8	Security Information and Event Management (SIEM) Implementation	David R. Miller	Syngress	1/e, 2018
9	AI Security: The Risks and Benefits of Artificial Intelligence	David K. Smith	CRC Press	1/e, 2021
10	AI Safety and Security	Roman Yampolskiy	Springer	1/e, 2018

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	<a href="https://www.youtube.com/watch?v=WWva3v9Hhfk&amp;pp=ygU1SW50cm9kdWN0aW9uIHRvIEFJIGFuZCBBDeWJlcnNIY3VyaXR5IA%3D%3D">https://www.youtube.com/watch?v=WWva3v9Hhfk&amp;pp=ygU1SW50cm9kdWN0aW9uIHRvIEFJIGFuZCBBDeWJlcnNIY3VyaXR5IA%3D%3D</a> <a href="https://onlinecourses.nptel.ac.in/noc24_cs81/preview">https://onlinecourses.nptel.ac.in/noc24_cs81/preview</a>
2	<a href="https://onlinecourses.nptel.ac.in/noc24_cs121/preview">https://onlinecourses.nptel.ac.in/noc24_cs121/preview</a>
3	<a href="https://onlinecourses.nptel.ac.in/noc24_cs85/preview">https://onlinecourses.nptel.ac.in/noc24_cs85/preview</a>
4	<a href="https://www.youtube.com/watch?v=PHWB1JSZdeA&amp;pp=ygUuQWRkcmVzc2luZyBBSSBTZWN1cm10eSBSaXNrcyBhbmQgRnV0dXJlIFRyZW5kcw%3D%3D">https://www.youtube.com/watch?v=PHWB1JSZdeA&amp;pp=ygUuQWRkcmVzc2luZyBBSSBTZWN1cm10eSBSaXNrcyBhbmQgRnV0dXJlIFRyZW5kcw%3D%3D</a>



## SEMESTER S6

### WIRELESS SENSOR NETWORKS

<b>Course Code</b>	24SJPECAT634	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To learn sensor network fundamentals
2. To understand the different routing protocols used in wireless sensor networks and identify the design issues.
3. To learn the transport layer security and the security issues in wireless sensor networks.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
1	<b>Wireless Sensor Networks:</b> Introduction to wireless sensor networks (WSN), Network architecture and protocol stack, MAC access control -fundamental MAC protocols, MAC design for WSNs, MAC protocols for WSN (Contention based, Contention free, and Hybrid protocols), IEEE 802.15.4, Zigbee	9
2	<b>Routing and Transport Layer:</b> Routing and data dissemination – Fundamentals and challenges, taxonomy of routing and data dissemination protocols – geographic adaptive fidelity, LEACH, Sensor protocols for information via negotiation, joint mobility and routing protocol. Transport protocols for WSNs, Operating systems for sensor networks - TinyOs, Contiki	10
3	<b>Security in WSNs:</b> Security requirements in WSNs, Security vulnerabilities in WSNs – DoS attacks, physical layer attacks, link layer, network layer, transport layer attacks, Attacks on secrecy and authentication, Security mechanisms for WSNs – cryptography in WSNs, Key management protocols, Defence against DoS attacks, Defence against routing attacks - TESLA, SPINS, Intrusion detection in WSNs.	10
4	<b>Infrastructure Establishment:</b> Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Real-world Applications of WSNs (e.g., Environmental Monitoring, Smart Cities, Industrial Automation).	7

**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
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

**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
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

**Course Outcomes (COs)**

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain the fundamentals of wireless sensor networks and the MAC mechanisms used in WSN	<b>K2</b>
<b>CO2</b>	Explain the transport layer functionalities and routing mechanisms used in wireless sensor networks	<b>K2</b>
<b>CO3</b>	Describe the security issues in wireless sensor networks	<b>K2</b>
<b>CO4</b>	Discuss the establishment of infrastructure of wireless sensor networks	<b>K2</b>

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	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓									✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Wireless Sensor Networks: A Networking Perspective	Jun Zheng, Abbas Jamalipour	John Wiley	1/e, 2009
2	Fundamentals of Wireless Sensor Networks - Theory and Practice	Waltenegus Dargie , Christian Poellabauer	John Wiley & Sons Publications	1/e, 2011
3	Wireless Sensor Networks- An Information Processing Approach	Feng Zhao & Leonidas J.Guibas	Elsevier	1/e, 2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Protocols and Architectures for Wireless Sensor Networks	Holger Karl, Andreas Willig	Wiley	1/e, 2005
2	Wireless Sensor Networks Technology, Protocols, and Applications	Kazem Sohraby, Daniel Minoli, & Taieb Znati	John Wiley	1/e, 2007

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	<a href="https://nptel.ac.in/courses/106/105/106105160/">https://nptel.ac.in/courses/106/105/106105160/</a>
2	<a href="https://cse.iitkgp.ac.in/~smisra/course/wasn.html">https://cse.iitkgp.ac.in/~smisra/course/wasn.html</a>
3	<a href="https://archive.nptel.ac.in/courses/106/105/106105160/">https://archive.nptel.ac.in/courses/106/105/106105160/</a>
4	<a href="https://codes.pratikkataria.com/infrastructure-establishment-wsn/#google_vignette">https://codes.pratikkataria.com/infrastructure-establishment-wsn/#google_vignette</a>

## SEMESTER 6

### DIGITAL IMAGE PROCESSING

(Common to CS/CA)

<b>Course Code</b>	<b>24SJPECST636</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L:T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### 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

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	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, 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, Quadrees, Other pyramidal structures.	<b>9</b>
<b>2</b>	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 local pre-processing operators, Detection of corners(interest points), Image Restoration - Degradations that are easy to restore, Inverse Filtering, Wiener Filtering	<b>8</b>

<b>3</b>	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 Matching, Template Matching, Control Strategies Templating, Evaluation Issues In Segmentation	<b>9</b>
<b>4</b>	Image Transforms - Discrete Cosine Transform, Wavelet transform, Eigen- analysis, Singular value decomposition, Principal component analysis Radon Transform; Image Compression - Image data Properties, Discrete Image Transforms in Image data compression, Predictive compression methods, Vector quantization, Hierarchical and Progressive Compression methods, Comparison of Compression Methods, JPEG and MPEG image compression JPEG still image compression, JPEG-2000 compression, MPEG full-motion video compression.	<b>10</b>

**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
<ul style="list-style-type: none"> <li>● 2 Questions from each module.</li> <li>● Total of 8 Questions, each carrying 3 marks</li> </ul> <p style="text-align: center;"><b>(8x3 =24 Marks)</b></p>	<ul style="list-style-type: none"> <li>● Each question carries 9 marks.</li> <li>● Two questions will be given from each module, out of which 1 question should be answered.</li> <li>● Each question can have a maximum of 3 subdivisions.</li> </ul> <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

**Course Outcomes (COs)**  
**At the end of the course students should be able to:**

Course Outcomes		Bloom's Knowledge Level (KL)
CO1	Understand the properties of monochrome and colour images and the data structures for image analysis	K2
CO2	Apply different preprocessing techniques to visualize image enhancement	K3
CO3	Understand the concept of image segmentation and various techniques used	K2
CO4	Understand the various transforms used for image processing	K2
CO5	Understand the concept of image compression and apply various image compression techniques	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	✓	✓	✓								✓
CO2	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

**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	Fundamentals 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

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>No.</b>	<b>Link ID</b>
<b>1</b>	<a href="https://archive.nptel.ac.in/courses/117/105/117105135/">https://archive.nptel.ac.in/courses/117/105/117105135/</a>
<b>2</b>	<a href="https://archive.nptel.ac.in/courses/106/105/106105032/">https://archive.nptel.ac.in/courses/106/105/106105032/</a>



## SEMESTER 6

### EMBEDDED SYSTEMS AND ITS APPLICATIONS

<b>Course Code</b>	<b>24SJPECAT637</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To learn the design concepts of embedded systems
2. To gain architectural level knowledge about embedded systems
3. To understand the recent trends in embedded system design.
4. To learn how to use embedded systems in real-world applications.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Fundamentals of Embedded Systems- complex systems and microprocessors- The Embedded System Design Process- Requirements, Specification, Architecture Design, Designing Hardware and Software Components design of hardware and software components- structural and behavioural description.	<b>8</b>
<b>2</b>	Hardware Software Co-Design and Program Modelling- Fundamental Issues. Design and Development of Embedded Product – Firmware Design and Development – Design Approaches, Firmware Development Languages.	<b>9</b>
<b>3</b>	Integration and Testing of Embedded Hardware and Firmware- Integration of Hardware and Firmware. Embedded System Development Environment – IDEs, Cross Compilers, Disassemblers, Decompilers, Simulators, Emulators and Debuggers. Embedded product development cycle (EDLC)-Different phases of EDLC, EDLC.	<b>9</b>
<b>4</b>	RTOS based Design – Basic operating system services. Interrupt handling in RTOS environment. Design Principles. Task scheduling models. How to Choose an RTOS. Recent Trends in Embedded Computing. Introduction to Embedded Systems in IT. IoT and Smart Devices	<b>10</b>

**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
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks</li> </ul> <p align="center"><b>(8x3 =24 marks)</b></p>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 subdivisions.</li> </ul> <p align="center"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

**Course Outcomes (COs)**

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

Course Outcomes		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain the basic idea about the embedded systems	<b>K2</b>
<b>CO2</b>	Describe the architectural design of the embedded system	<b>K2</b>
<b>CO3</b>	Identify the role of different software modules in the development of an embedded system	<b>K2</b>
<b>CO4</b>	Apply embedded systems in real-world applications.	<b>K3</b>

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
<b>CO1</b>	✓	✓									✓
<b>CO2</b>	✓	✓									✓
<b>CO3</b>	✓	✓									✓
<b>CO4</b>	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Hardware/Software Co-Design: Principles and Practice	Staunstrup, J. Wolf, Wayne	Springer	1/e,2007
2	Embedded Systems: Architecture, Programming and Design	Raj Kamal	McGraw Hill	3/e, 2014
3	Introduction to Embedded Systems	Shibu K.V	McGraw Hill	1/e,2009

<b>Reference Book</b>				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computers as Components-Principles of Embedded Computer System Design	Wayne Wolf	Morgan Kaufmann	3/e,2012

<b>Video Links (NPTEL, SWAYAM...)</b>	
Module No.	Link ID
1	Embedded systems , IITDelhi <a href="https://www.youtube.com/watch?v=y9RAhEflfJs&amp;list=PL90187D2B8F5AC28F">https://www.youtube.com/watch?v=y9RAhEflfJs&amp;list=PL90187D2B8F5AC28F</a>
4	Real time operating systems , IIT Khargpur <a href="https://www.youtube.com/playlist?list=PLJ5C_6qdAvvBH-JNRilupFb44miyx9M8JD">https://www.youtube.com/playlist?list=PLJ5C_6qdAvvBH-JNRilupFb44miyx9M8JD</a>

## SEMESTER 6

### CLOUD COMPUTING

(Common to CS/CA)

<b>Course Code</b>	<b>24SJPECST635</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:1	<b>ESE Marks</b>	60
<b>Credits</b>	5/3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To learn fundamentals of cloud and configure cloud environments, deploy virtual machines, and work with containerization tools, gaining practical skills.
2. To learn to identify and address common security threats in cloud environments, implementing best practices to ensure the safety and compliance of applications.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Introduction - Limitations of Traditional Computing & solution, Three Layers of Computing, Factors behind Cloud Service Adoption; Evolution and Enabling Technologies of Cloud; Benefits and Challenges; [Text 2] Fundamental Concepts and Models - Roles and Boundaries, Cloud Characteristics, Cloud Delivery Model (-Infrastructure-as-a-Service (IaaS), Platform-as-a-Service(PaaS),Software-as-a-Service(SaaS),XaaS (Anything-as-a-service)), Cloud Deployment Models-(Public cloud, Community cloud, Private cloud, Hybrid cloud.) [Text 1] Introduction to Cloud Providers (AWS, Azure, Google Cloud). <b>Hands on</b> - Cloud Account Setup and Virtual Machine Deployment - Create accounts on a cloud provider and deploy virtual machine instances, and document the process and inferences.	<b>8</b>
<b>2</b>	Cloud-Enabling Technology - Networks and Internet Architecture, Cloud Data Center Technology, Modern Virtualization, Multitenant Technology, Service Technology and Service APIs; Understanding Containerization - Influencers, Fundamental Virtualization and Containerization, Understanding Container Images, Multi-Container Types. [Text 1] <b>Hands on</b> - Hypervisor and Containers installation - Install hypervisors and deploy VMs on local machines.	<b>10</b>

<b>3</b>	Resource Management - Resource Pooling, Sharing, Provisioning; Scaling in Cloud and the Strategies; Storage and File System - Challenges; Cloud Native File System, Deployment models, Storage Types, Popular Cloud Storages. Map Reduce – Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark [Text 2] <b>Hands on</b> - Use Map-reduce to implement basic big data applications such as word count.	<b>9</b>
<b>4</b>	Understanding Cloud Security - Basic Security Terminology, Basic Threat Terminology, Threat Agents, Common Threats; Other Considerations - Flawed Implementations, Security Policy Disparity, Contracts, Risk Management. [Text 1] <b>Hands on</b> : Identify possible attacks of any selected cloud applications and suggest/implement solutions/policies for mitigation.	<b>7</b>

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

**Continuous Internal Evaluation Marks (CIE):**

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

**Criteria for Evaluation (Evaluate and Analyse): 20 marks**

**Ways of assessing at**

1. Analyze level - Analyze performance of traditional models (Hardware, Application, Computing / security models) against that in the cloud.
2. Evaluate level - Derive conclusions on the cloud programming / computing / security models based on standard performance evaluation criteria.

**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*

<b>Part A</b>	<b>Part B</b>	<b>Total</b>
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks <b>(8x3 =24 marks)</b></li> </ul>	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.  <p style="text-align: center;"><b>(4x9 = 36 marks)</b></p>	<b>60</b>

### Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Evaluate the limitations of traditional computing models and recognize the factors driving cloud service adoption and compare between various cloud delivery and deployment models.	<b>K5</b>
<b>CO2</b>	Demonstrate proficiency in cloud-enabling technologies, including modern virtualization and containerization	<b>K3</b>
<b>CO3</b>	Examine the resource management within the cloud, including resource pooling, scaling strategies, and storage management and utilize tools like MapReduce for processing big data applications.	<b>K4</b>
<b>CO4</b>	Identify potential security threats in cloud environments and apply appropriate security measures to mitigate these risks.	<b>K3</b>

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
<b>CO1</b>	✓	✓	✓	✓	✓						✓
<b>CO2</b>	✓	✓	✓	✓	✓						✓
<b>CO3</b>	✓	✓	✓	✓	✓						✓
<b>CO4</b>	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cloud Computing: Concepts, Technology, Security, and Architecture	Thomas Erl	Pearson	2/e, 2023
2	Cloud Computing	Sandeep Bhowmik	Cambridge University Press	1/e, 2017

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Cloud Computing : Theory and Practice	Dan C. Marinescu	Morgan Kaufman	3/e, 2023
2	Cloud Computing: A Hands-On Approach	Arshdeep Bahga and Vijay Madisetti	Universities Press	1/e, 2014
3	Mastering Cloud Computing	Rajkumar Buyya, Christian Vecchiola S.Thamarai Selvi	Morgan Kaufman	1/e, 2013
4	Cloud Computing : A Practical Approach	Anthony T. Velte, Toby J. Velte, Robert Elsenpeter	McGraw Hill	1/e, 2010

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>No.</b>	<b>Link ID</b>
1	<a href="https://archive.nptel.ac.in/courses/106/105/106105167/">https://archive.nptel.ac.in/courses/106/105/106105167/</a>

## SEMESTER 6

### MOBILE APPLICATION DEVELOPMENT

(Common to CS/CA)

<b>Course Code</b>	<b>24SJPECST630</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:1	<b>ESE Marks</b>	60
<b>Credits</b>	5/3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To equip students with a thorough understanding of mobile application development fundamentals, including platforms (iOS and Android) and architectures (MVC, MVVM, BLoC).
2. To instill proficiency in Flutter and Dart: Enable students to use Flutter effectively for cross-platform development and the Dart programming language to create responsive, user-friendly mobile applications.
3. To prepare students for real-world scenarios by teaching app security, testing, CI/CD, and deployment processes, culminating in the development and deployment of a complete mobile application project.

#### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
1	<b>Fundamentals of Mobile Application Development:</b> Introduction to Mobile Application Development, Overview of Mobile Platforms: iOS and Android, Introduction to Flutter: History, Features, and Benefits, Setting Up the Flutter Development Environment, Mobile App Architectures (MVC, MVVM, and BLoC), Basics of Dart Programming Language, Introduction to Git and Version Control <b>Assignments/Projects:</b> Set up the Flutter environment and create a simple "Hello World" application. ( <i>Use Git: cloning, committing, pushing, and pulling</i> )  <i>Milestone 1: Develop a basic app with a simple UI and basic functionality.</i>	9

<b>2</b>	<p><b>User Interface Design and User Experience:</b> Principles of Mobile UI/UX Design, Designing Responsive UIs with Flutter, Using Flutter Widgets: StatelessWidget and StatefulWidget, Layouts in Flutter: Container, Column, Row, Stack, Navigation and Routing in Flutter, Customizing UI with Themes and Styles, Introduction to Material Design and Cupertino Widgets</p> <p><b>Assignments/Projects:</b> Design and implement a user interface using Flutter widgets. <i>Milestone 2:</i> Enhance the project from Module 1 with a multi-screen UI, navigation, and customized themes.</p>	<b>9</b>
<b>3</b>	<p><b>Advanced Flutter Development:</b> State Management in Flutter: Provider, Riverpod, and BLoC Networking in Flutter: HTTP Requests, JSON Parsing, RESTful APIs Data Persistence: SQLite, SharedPreferences, Hive Asynchronous Programming with Dart: Futures, async/await, and Streams Integrating Device Features: Camera, GPS, Sensors Working with Firebase: Authentication, Firestore, Cloud Functions</p> <p><b>Assignments/Projects:</b> Develop an app with state management and data persistence. <i>Milestone 3:</i> Enhance the project with state management, data persistence, and integration with a RESTful API or Firebase.</p>	<b>9</b>
<b>4</b>	<p><b>Industry Practices and App Deployment:</b> Advanced UI Components and Animations, App Security Best Practices, Testing and Debugging Flutter Applications, Continuous Integration/Continuous Deployment (CI/CD) with Flutter, Publishing Apps to Google Play Store and Apple App Store, Industry Trends and Future of Mobile Development with Flutter</p> <p><b>Assignments/Projects:</b> Add advanced UI components and animations to the project, Implement security measures in the Flutter application, Conduct thorough testing and debugging of the developed app. <i>Milestone 4:</i> Complete the project, integrating all features and preparing it for deployment.</p>	<b>9</b>

### Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

#### Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

## Criteria for Evaluation (Evaluate and Analyse): 20 marks

### Analyze

Key Actions: Differentiate, Organize, Attribute

Metrics and Examples:

#### 1. Code Review and Refactoring:

- a. Task: Students are given a piece of code to analyze and refactor for better performance or readability.
- b. Metric: Ability to identify inefficient or redundant code and provide optimized solutions.

Example: Analyzing a complex UI widget tree and reorganizing it for better performance and maintainability.

#### 2. Design Pattern Identification:

- a. Task: Students are asked to identify and apply appropriate design patterns for given scenarios.
- b. Metric: Correct identification and application of design patterns like Singleton, Factory, or BLoC in their projects.

Example: Analyzing an app's state management needs and choosing between Provider and BLoC patterns.

#### 3. Bug Diagnosis:

- a. Task: Students are given a buggy piece of code to analyze and debug.
- b. Metric: Ability to use debugging tools and techniques to locate and fix bugs.

Example: Analyzing asynchronous code to identify and resolve race conditions or memory leaks.

### Evaluate

Key Actions: Check, Critique, Judge

Metrics and Examples:

#### 1. Code Quality Assessment:

- a. Task: Students review each other's code and provide constructive feedback.
- b. Metric: Ability to critically evaluate code quality based on readability, efficiency, and adherence to best practices.

Example: Peer review sessions where students critique the structure and efficiency of each other's Flutter code.

## 2. UI/UX Design Evaluation:

- a. Task: Students evaluate the user interface and user experience of their peers' applications.
- b. Metric: Ability to judge UI/UX designs based on usability, accessibility, and aesthetics.

Example: Conducting usability testing sessions and providing feedback on navigation flow, design consistency, and user engagement.

## 3. Project Presentation and Defense:

- a. Task: Students present their projects and justify their design and implementation choices
- b. Metric: Ability to articulate design decisions, defend architectural choices, and respond to critical questions.

Example: End-of-module presentations where students explain their choice of state management, navigation strategy, and performance optimizations.

### **Integration into the Syllabus - Example Use Cases**

#### Basic Mobile Application Development

- Analyze: Evaluate different mobile app architectures (MVC, MVVM, BLoC) and choose the best fit for a given project scenario.
- Evaluate: Critically assess the setup and configuration of the Flutter development environment for potential improvements.

#### User Interface Design and User Experience

- Analyze: Analyze the responsiveness and usability of designed UIs, identifying potential bottlenecks.
- Evaluate: Critique the effectiveness of navigation and routing within the app.

#### Advanced Flutter Development

- Analyze: Break down the integration process of advanced features (state management, networking) and evaluate their impact on app performance.
- Evaluate: Judge the robustness of data persistence solutions and asynchronous programming implementations.

#### Industry Practices and App Deployment

- Analyze: Analyze the app's security measures and their effectiveness in protecting user data.
- Evaluate: Evaluate the completeness and readiness of the app for deployment based on industry standards and best practices.

### Example Evaluation Rubrics

#### Analyze:

Criterion	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
Identification of Code Inefficiencies	Identifies all inefficiencies and provides optimal solutions	Identifies most inefficiencies and provides good solutions	Identifies some inefficiencies with basic solutions	Struggles to identify inefficiencies or provide solutions
Application of Design Patterns	Correctly applies design patterns with a clear rationale	Applies design patterns with minor issues	Applies design patterns with significant issues	Incorrectly applies or fails to apply design patterns

#### Evaluate:

Criterion	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
Code Quality Assessment	Provides thorough, insightful feedback with constructive suggestions	Provides good feedback with some constructive suggestions	Provides basic feedback with limited constructive suggestions	Provides minimal or unhelpful feedback
UI/UX Design Evaluation	Provides detailed critique with actionable insights	Provides good critique with some actionable insights	Provides basic critique with limited actionable insights	Provides minimal or no critique

#### 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
<ul style="list-style-type: none"> <li>2 Questions from each module.</li> <li>Total of 8 Questions, each carrying 3 marks (8x3 =24marks)</li> </ul>	2 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. Each question carries 9 marks. (4x9 = 36 marks)	<b>60</b>

## Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain mobile application development using Flutter and different mobile platforms.	<b>K2</b>
<b>CO2</b>	Apply principles of effective mobile UI/UX design, Create responsive user interfaces using Flutter features.	<b>K3</b>
<b>CO3</b>	Experiment effectively with state in Flutter application, networking and data persistence.	<b>K4</b>
<b>CO4</b>	Apply security best practices in mobile app development, test, and debug Flutter applications effectively.	<b>K5</b>
<b>CO5</b>	Set up CI/CD pipelines for Flutter projects and deploy mobile apps to Google Play Store and Apple App Store.	<b>K5</b>

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

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

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<b>CO1</b>	✓	✓	✓	✓							✓
<b>CO2</b>	✓	✓	✓	✓	✓						✓
<b>CO3</b>	✓	✓	✓	✓	✓						✓
<b>CO4</b>	✓	✓	✓	✓	✓						✓
<b>CO5</b>	✓	✓	✓	✓	✓						✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flutter Cookbook	Simone Alessandria	Packt	2/e, 2023
2	Flutter for Beginners	Alessandro Biessek	Packt	1/e, 2019

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Flutter in Action	Eric Windmill	Manning	1/e, 2019
2	Flutter and Dart: Up and Running	Deepthi Chopra, Roopal Khurana	BPB	1/e, 2023
3	Managing State in Flutter Pragmatically	Waleed Arshad	Packt	1/e, 2021
4	Ultimate Flutter Handbook	Lahiru Rajeeendra Mahagamage	Orange House	1/e, 2023

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>No.</b>	<b>Link ID</b>
<b>1</b>	<a href="https://www.youtube.com/watch?v=VPvVD8t02U8">https://www.youtube.com/watch?v=VPvVD8t02U8</a>