THE NATIONAL INSTITUTE OF ENGINEERING

MYSORE – 8

(Autonomous Institution under VTU)

B.E - CSE (AI&ML)

Scheme of V – VI Semester

Department of Computer Science and Engineering

The National Institute of Engineering

Scheme of Teaching & Examination (2022 Scheme)

Department: Computer Science and Engineering (BE in CS&E (AI and ML))

B.E. 2023 Admitted Batch

V Semester

Sl.No	Type of Course	Course Code	Course Title	Teaching Department (TD)	Question Paper setting Board (PSB)	Teaching Hrs/Week				Examination				Credits
						L	T	P	S	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	HSMS	BCS501	Software Engineering & Project Management	CS	CS	3	0	0		3	50	50	100	**3**
2	IPCC	BCS502	Computer Networks	CS	CS	3	0	2		3	50	50	100	**4**
3	PCC	BCS503	Automata Theory and Computation	CS	CS	3	2	0		3	50	50	100	**4**
4	PCCL	BIL5B04	Machine Learning Algorithms Lab	CS	CS	0	0	2		2	50	50	100	**1**
5	PCC	BCI505	Machine Learning	CS	CS	3	0	0		3	50	50	100	**3**
6	PEC	BCI516X	Professional Elective Course (Industry suggested course) - Group I	CS	CS	3	0	0		3	50	50	100	**3**
7	PROJ	BCI586	Minor Project	CS	CS	0	0	2		-	50	-	50	**1**
8	AEC	BRMCS557	Research Methodology and IPR	CS	CS	2	0	0		2	50	50	100	**2**
9	MC	BESK508	Environmental Studies	Civil Engg.	Civil	1	0	0		-	50	-	50	**1**
10	MC	BNSK559	National Service Scheme (NSS)	NSS Coordinator		0	0	2		_	100	_	100	**0**
		BPEK559	Physical Education (PE) (Sports & Athletics)	PED										
		BYOK559	Yoga	Yoga Teacher										
		BMUK559	Music	Music Teacher										
										Total	**550**	**350**	**900**	**22**

Professional Elective Course - Group I			
BCI516B	Information Retrieval	BCI516E	Pervasive Computing
BCI516C	Nonlinear Control Techniques		
BCI516D	Image and Video Processing		

Code:BCS501 **Course: Software Engineering & Project Management**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50% **CIE:50%**

SEE Hours:3 **Max.Marks:100**

Prerequisites if any	**NIL**
Learning objectives	1. Learn fundamental software engineering processes and models. 2. Learn to apply analysis and modeling techniques for real-world software. 3. Learn to validate software using effective testing strategies 4. Learn to employ suitable software project estimation models.

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the principles of software engineering, process models and agile practices for structured software development.	Understand
CO2	Apply suitable requirement analysis and modeling techniques to design software solutions for real-world applications.	Apply
CO3	Analyze software quality by employing appropriate testing strategies and project estimation methods for software development and people management.	Analyze
CO4	Formulate, present the role-play and outcomes as a team to simulate real-world project scenarios.	Evaluate

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	2	3	-	3		1	-
CO2	3	2	3	3	2	-	-	-	2	2	-	3		2	-
CO3	2	2	2	3	2	-	-	-	2	2	-	3		3	-
CO4	2	3	3	2	2	2	-	3	3	3	3	3		1	2

Mapping with Pos and PSOs:

Mapping Strength: Strong–3 Medium – 2 Low– 1

Course Structure

Nos.	Module	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module -1			
1.1	Introduction: The Nature of Software - Software application domains	**2**	-	-
1.2	Software Process : Software Engineering A layered Technology Process Frame work Generic Process model	**3**	-	-
1.3	Process Models: Incremental Process Models Evolutionary Process models: Prototyping, Spiral model	**3**	-	-
	Module – 2			
2.1	Agile View of Process: Agility, Agile Process Agile Process Model: Extreme programming (XP) Scrum	**3**	-	-
2.2	Requirement Engineering: Introduction to requirement engineering Requirement Engineering Tasks Initiating Requirement Engineering Process Developing USE-CASE	**4**	-	-
	Module – 3			
3.1	Building The Analysis Model: Requirement Analysis , Data Modeling concept, Analysis Modeling Approach Scenario Based Modeling Flow Based Modeling Behavioral Modeling	**4**	-	-
3.2	Design Engineering: Design Process Design Quality Design Concepts	**4**	-	-
3.3	Creating an Architectural Design: Software Architecture Data Design Architectural Styles and Patterns	**3**	-	-
	Module - 4			
4.1	Testing Strategies: A Strategic Approach to Software Testing, Test Strategies for Conventional Software Unit Testing and Integration Testing Validation testing	**3**	-	-

4.2	Testing Tactics: Software Testing Fundamentals Black Box & White Box Testing Basis Path Testing ,Black Box Testing	**4**	**-**	**-**
	Module – 5			
5.1	Project Management: Project Management Spectrum People, Product Process, Project	**3**	**-**	**-**
5.2	Software Project Estimation: Decomposition Techniques Software Project Estimation: Decomposition Techniques Empirical Estimation Models	**3**	**-**	**-**
5.3	Report writing	**1**	**-**	
	Total No. of Lecture Hours	**40**		
	Total No. of Tutorial Hours		**0**	
	Total No. of Practical Hours			**0**

Text Book :

1. **Software Engineering: A Practitioners Approach – Roger S. Pressman, 7th Edition, McGraw-Hill 2010**

Reference Books:

1. **Software Engineering: Ian Somerville, 10th Edition, Pearson Education, 2016.**
2. **Software Engineering Theory and Practice: Shari Lawrence Pfleeger, Joanne M. Atlee, 3rd Edition, Pearson Education, 2006.**
3. **Software Engineering Principles and Practice: Waman S Jawadekar, Tata McGraw Hill, 2004**

Online Resources:

1. **https://www.digimat.in/nptel/courses/video/106101061/L01.html**
2. **https://www.digimat.in/nptel/courses/video/106105182/L01.html**
3. **https://www.coursera.org/learn/software-processes-and-agile-practices**

Course Code: BCS502 **Course Name: Computer Networks**

Credits:4 **L:T: P- 3:0:2**

SEE:50%Marks **CIE:50%Marks**

SEE Hours: 3 **Max.Marks:100**

Prerequisites if any	Basic concepts of communication, Digital electronics and computers.
Learning objectives	1.To Understand the fundamentals of computer networks by studying networking models and the services provided at the network layer. 2. To analyze the mechanisms of IPv4 and IPv6 addressing and apply subnetting concepts for efficient network design 3. To analyze the services and operations of protocols in the Network, Transport, and Application layers. 4. Implement networking concepts and protocol functionalities in simulated environments using Cisco Packet Tracer.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the fundamental principles of Computer Networks, Networking models and the operations of core protocols.	Understand
CO2	Apply IPv4/IPv6 addressing, forwarding methods, routing protocols to enable efficient data transmission across networks.	Apply
CO3	Apply transport layer protocols and mechanisms to ensure reliable and optimal communication.	Apply
CO4	Analyze application-layer protocols and socket programming concepts for standard client-server communication.	Analyze
CO5	Implement networking concepts and protocol functionalities in simulated environments using Cisco Packet Tracer.	Evaluate

Mapping of COs with Pos and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2					2	1	3	2	2
CO2	3	3	3	2	2					2	1	3	3	3
CO3	3	3	2	2	2					2	1	3	3	3
CO4	3	3	2	2	2					2	1	3	3	3
CO5	3	3	3	2	3	1	1	1	2	2	1	3	3	3

Mapping Strength: Strong–3 Medium – 2 Low–1

Course Structure

Sl. No.	Modules	No. of Lecture Hours	No. of TutorialHours	No. of Practical Hours
Module–1: Introduction to Computer Networks andNetworkLayer				
1.1	Networks	1	-	-
1.2	Network Types	1		
1.3	**Networks Models:** TCP/IP Protocol Suite, The OSI Model.	1		
1.4	**Network Layer:** Network layer services: Packetizing, Routing and forwarding, other services	1	-	-
1.5	**Packet switching:** Datagram approach, Virtual-Circuit approach	1	-	-
1.6	Network layer performance	1	-	-
Module–2:NetworkLayer-PartI				
2.1	IPv4addresses:Addressspace,Classfull addressing	1	-	-
2.2	Classlessaddressing	2	-	-
2.3	DHCP,NAT	1	-	-
2.4	ForwardingofIPPackets:ForwardingBasedonDestinationAddress	1		
2.5	**NetworkLayerProtocols:**InternetProtocol, (IP):IPV4Datagram format	1	-	-
2.6	FragmentationOptions,	1	-	-
2.7	SecurityofIPV4datagram,ICMPChecksum	1	-	-
2.8	**NextGenerationIP:**IPV6Addressing	1	-	-
2.9	TheIPV6 Protocol	1	-	-
Module–3: NetworkLayer-PartII				
3.1	**UnicastRouting:**RoutingAlgorithms:DistanceVector Routing,	1	-	-
3.2	LinkstateRouting	1		
3.3	UnicastRoutingProtocols:RoutingInformationProtocol(RIP)	1	-	-
3.4	OSPF	1	-	-
3.5	BorderGatewayProtocol(BGP):operationofExternalBGP(eBGP), OperationofInternalBGP (eBGP)	2	-	-
3.6	**Multicast Routing:** Introduction, Unicasting, Multicasting, broadcasting	1	-	-
3.7	MOSPF	1	-	-
Module–4:Transport Layer				
4.1	**Transport Layer:** Transport Layer Services: process-to-process communication,ICANNRanges,EncapsulationandDecapsulation, MultiplexingandDemultiplexing,FlowcontrolandError Control	1	-	-
4.2	Connectionlessandconnection-orientedservice,TransportLayer protocols: Introduction, services, port numbers	1	-	-
4.3	UserDatagramProtocol:UserDatagramandUDPservices	1	-	-
4.4	TransmissionControlProtocol:TCPservices,TCPfeatures, Segment			
4.5	TCPconnection,WindowsinTCP,Flowcontrol(inbrief)			
4.6	Error control: checksum, acknowledgement, generating acknowledgement, Retransmission- Retransmission after RTO, Retransmission after 3 duplicates, Out of order segments			
4.7	TCPcongestioncontrol:congestionwindow,congestiondetection, Congestionpolicies,fast recovery	1	-	-

Module–5:ApplicationLayer				
5.1	**Application Layer:** Application-Layer Paradigms, Application Programming Interface (Socket and socket address)	2	-	-
5.2	**Standard Client Server Protocols:** World Wide Web	1	-	-
5.3	HTTP	1		
5.4	FTP	1	-	-
5.5	Electronic Mail	1		
5.6	TELNET	1		
5.7	Secure Shell (SSH)-components, Domain Name System (DNS)	1	-	-
	TotalNo. ofHours	**40Hours**		

List ofExperiments				
1	StudyofnetworkingdeviceslikeHub,Repeater,Bridge,Switch, Router, Gateway, Access point, MODEM and NIC			1
2	WriteaprogramtoimplementthefollowingErrorDetection Techniques a. CyclicRedundancyCheck(CRC) b. Checksum			1
3	a) IntroductiontoCiscopackettracer. b) CreatebasictopologiesandassignIPaddress,subnet mask,gatewayIPaddressandtestconnectivityusing PING command.			1
4	Perform: a) AnInitialSwitchConfiguration. (Host name, Console password, vty password, Privileged EXEC mode password, Privileged EXEC mode secret, IP address on VLAN1 interface, Default gateway) b) AnInitialRouterConfiguration. (Configure the router host name, configure the passwords, configure the banner messages, verify the router configuration)			1
5	ConfigureandimplementDHCPserviceinaLocalAreaNetwork. also ConfigureCiscoRouterasaDHCPsever.			1
6	a. ImplementtheStaticRoutingandDefaultRouting. b. ConfigureWEPonaWireless Router.			1
7	ConfigureDynamicRoutingusingRIP.			1
8	UsingTCP/IPsockets,writeaclient–serverprogramtomakethe client send the file name and to make the server send back the contents of the requested file if present.			1
9	Configure and implement DNS service.			1
10	DefiningandusingAccessControlLists.			1
	TotalNo. ofLectureHours	**40**	**-**	**-**
	TotalNo. ofTutorialHours		**00**	**-**
	TotalNo. OfPracticalHours			**10**

Textbook:

1. **1.Behrouz Forouzan," Data Communications and Networking", TataMcGraw-Hill, 5th Edition, 2 013.**

Module1:

Chapter1:1.2,1.3 Chapter2:2.2,2.3

Chapter18:18.2,18.3,18.4(18.4.1,18.4.2,18.4.3,18.4.4,18.4.5)

Module2:

Chapter18:18.5(18.5.1**)** Chapter19: 19.1.1,19.1.2,19.1.3,19.1.4,19.2.3

Chapter22: 22.1,22.2

Module3:

Chapter20:20.2(20.2.1,20.2.2),20.3(20.3.2,20.3.3,20.3.4) Chapter21:21.1,21.3.2

Module4:

Chapter23:23.1.1,

Chapter24:24.1(24.1.1,24.1.2),24.2(24.2.1,24.2.2),24.3(24.3.1,24.3.2,24.3.3,24.3.4,24.3.6,24.3.7,24.3.8,24.3.9)

Module5:

Chapter25:25.1.2,25.2.1

Chapter26:26.1(26.1.1,26.1.2),26.2,26.3(26.3.1),26.4,26.5(26.5.1),26.6.

Reference Book:

1. Larry Peterson and Bruce S Davis "Computer Networks: A System Approach 5th Edition, Elsevier-2014
2. Computer Networks, Andrew S. Tanenbaum, Pearson Education, 4thEdition, 2002.
3. Data and Computer Communication, WilliamStallings, Pearson Education, 8thEdition,2007

Online Resources:

https://archive.nptel.ac.in/courses/106/105/10610518

Code: BCS503 **Course: AutomataTheoryand Computation**

Credits:4 **L:T:P-3:2:0**

SEE: 50 Marks **CIE:50 Marks**

SEEHours:3 **Max.Marks:100**

Prerequisites if any	AnyProgramminglanguage,DiscreteMathematicalstructures
Learning objectives	1. To give an overview of the theoretical foundations of computer science from the perspectiveofformallanguagesandillustratefinitestatemachinestosolveproblemsin computing 2. TofamiliarizeRegulargrammars,contextfreesgrammar andalsotoexplainthehierarchy of problems arising in the computer sciences.

Course Outcomes:

Onthesuccessful completion of thecourse,thestudent will be ableto

COs	Course Outcomes	Bloom's level
CO1	Explain the basic concepts of formal languages of finite automata techniques	Understand
CO2	Apply Finite Automata techniques to recognize the given Formal Languages	Apply
CO3	Analyze computational problems to determine the appropriate automata for their recognition	Analyze
CO4	Evaluate the suitability of Finite Automata Models for solving computational problems	Evaluate

MappingwithPOsandPSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	1	2	3	-	-	-	-	2	2	-	2		1	1
CO2	3	2	2	2	3	-	-	-	3	3	-	2		3	3
CO3	3	3	3	3	-	-	-	-	3	3	-	2		3	3
CO4	3	3	2	3	-	-	-	-	3	3	-	2		3	3

MappingStrength:Strong–3 Medium – 2 Low– 1

Course Structure

Sl.No	Modules	No.ofLecture Hours	No.ofTutorial Hours	No. of Practical Hours
Module–1:IntroductiontoAutomataTheory				
1.1	CentralConceptsofAutomata Theory	1		
1.2	FiniteAutomata-DeterministicFiniteAutomata	2	1	
1.3	NonDeterministicFiniteAutomata,NFAtoDFA	2		
1.4	FiniteAutomatawithEpsilon Transitions	1		
1.5	Elimination of EpsilonTransitions	2	1	
Module–2:RegularExpressionsand Languages				
2.1	RegularExpressions	2		
2.2	FiniteAutomataandRegularExpressions–DFAto Regular Expression – Kleen's closure	2	1	
2.3	Finite Automata to Regular Expression – State elimination	2		
2.4	RegularExpression toFiniteautomata	1	1	
2.5	ApplicationsofRegularExpressions	1		
Module–3:Properties ofRegularLanguages,ContextFreeGrammars				
3.1	ProvingLanguagesnot toberegular,ClosureProperties of regular languages	2		
3.2	EquivalenceandMinimizationof Automata	2	1	
3.3	ContextFreeGrammars	2	1	
3.4	Leftmost, rightmost Derivations, Parse Trees, Ambiguity in Grammars	2		
Module–4:PushdownAutomata				
4.1	PushdownAutomata,LanguagesofPDA	2	1	
4.2	EquivalenceofPDAand CFG–GrammarstoPDA	2		
4.3	EliminationofEpsilon,UnitProductions,Uselessproductions	2	1	
4.4	ChomskyNormalForm	2	1	
Module–5:TuringMachines				
5.1	IntroductiontoTuringMachines	2		
5.2	Notation,Instantaneousdescriptionandtransitionsof Turning Machine	2	1	
5.3	Post'sCorrespondenceProblem	2		
5.4	IntroductiontoClassPandNP problems	2		
TotalNo.ofLectureHours		**40**	**-**	**-**
TotalNo. ofTutorial Hours			**10**	**-**
TotalNo. ofPractical Hours				**00**

Textbook:

1. JohnEHopcroft,RajeevMotwani,JeffreyDUllman,IntroductiontoAutomataTheory, Languages, and Computation, 3rd Edition, Pearson Education

ReferenceBook:

1. Sipser,Michael.IntroductiontotheTheoryofComputation.3rded.CengageLearning, 2012. ISBN: 9781133187790.
2. PeterLinz,An IntroductiontoFormalLanguages andAutomata

Machine Learning Algorithms Lab		Semester	5
Course Code	**BCIL504**	CIE Marks	50
Teaching Hours/Week(L: T:P)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	2
Examination type(SEE)	Practical		

Course outcomes:

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

1. Demonstrate proficiency in using Python libraries for machine learning tasks.
2. Develop the ability to carry out an end-to-end machine learning project.
3. Implement and evaluate various machine learning algorithms.
4. Apply dimensionality reduction techniques and understand their impact on machine learning models.
5. Implement unsupervised learning techniques for clustering.

MappingwithPOsandPSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	-	-	-	2	-	1	2	2
CO2	3	3	3	3	3	-	-	-	2	2	1	2	3	3
CO3	3	3	3	3	2	-	-	-	-	2	-	2	3	3
CO4	3	2	3	3	2	-	-	-	-	1	-	2	3	3
CO5	3	2	3	3	2	-	-	-	-	1	-	2	3	3

Sl.No	CO's	Experiments
1	CO1	**Introduction to Python for Machine Learning** **Objective**: Install necessary libraries and set up the environment for machine learning in Python. **Tasks**:Install Anaconda (or another Python distribution suitable for data science). Create a new Python environment specifically for machine learning projects. Write a Python script to install numpy, pandas, matplotlib, scikit-learn, and tensorflow. Import these libraries and print their versions.
2	CO1 & CO2	**End-to-End Machine Learning Project** **Objective**: Work through a complete machine learning project. **Tasks**: Use a real-world dataset, perform data cleaning, feature engineering, model training, and evaluation.

3	CO3	**Implementing Bayesian Decision Theory** **Objective**: Implement Bayesian Decision Theory for classification. **Tasks**: Write a Python program to classify a given dataset using Bayesian Decision Theory.
4	CO3	**Classification Using MNIST Dataset** **Objective**: Implement a classifier for the MNIST dataset. **Tasks**: Train a binary classifier on the MNIST dataset and evaluate its performance using various metrics.
5	CO3	**Training and Evaluating Linear Regression Models** **Objective**: Implement linear regression and evaluate its performance. **Tasks**: Use a suitable dataset to train a linear regression model and evaluate its performance using metrics such as RMSE and R^2 score.
6	CO3	**Regularized Linear Models** **Objective**: Implement Ridge and Lasso regression. **Tasks**: Compare the performance of Ridge and Lasso regression on a dataset and analyze the effect of regularization.
7	CO4	**Dimensionality Reduction Techniques** **Objective**: Apply PCA and LDA for dimensionality reduction. **Tasks**: Implement PCA and LDA on a high-dimensional dataset and visualize the results.
8	CO3	**Support Vector Machines** **Objective**: Train and evaluate SVM classifiers. **Tasks**: Implement linear and kernelized SVMs on a given dataset and compare their performance.
9	CO3	**Decision Trees and Random Forests** **Objective**: Implement and evaluate decision trees and random forests. **Tasks**: Train a decision tree and a random forest classifier on a dataset, visualize the trees, and evaluate their performance.

10	CO5	**Clustering Algorithms** **Objective**: Implement various clustering algorithms. **Tasks**: Apply K-means, Spectral, and Hierarchical clustering on a dataset and compare the clustering results.

Suggested Learning Resources:

Textbook:

1. Introduction to Machine Learning by Ethem Alpaydin
2. Hands-on Machine Learning with Scikit-Learn and TensorFlow by Aurélien Géron

VirtualLabs(CSE):

1. http://cse01-iiith.vlabs.ac.in/
2. https://playground.tensorflow.org/

Code: BCI505 **Course: MACHINE LEARNING**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	None
Learning objectives	1. Acquire theoretical Knowledge on setting hypothesis for pattern recognition. 2. Apply suitable machine learning techniques for data handling and to gain knowledge from it. 3. Evaluate the performance of algorithms and to provide solution for various real-world applications.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the basic principles of Learning theories, dimensionality reduction and feature selection techniques	Understanding
CO2	Develop a wide variety of supervised learning algorithms	Apply
CO3	Analyze suitable supervised / unsupervised learning algorithms for a given scenario	Analyze
CO4	Evaluate decision trees and random forest algorithms judiciously, and choose appropriate unsupervised machine learning algorithms for unlabeled data.	Evaluate

Mapping with POs and PSOs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2
CO 1	3	-	-	-	-	-	-	-	-	-	-	3		2	2
CO 2	3	3	3	2	3	-	-	-	2	2	-	3		3	2
CO 3	3	3	2	2	2	-	-	-	2	2	-	3		2	2
CO 4	3	3	2	3	3	-	-	-	2	2	-	3		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: The Machine Learning Landscape				
1.1	**The Machine Learning Landscape**: What Is Machine Learning (ML)? Uses and Applications with examples	2		
1.2	Types of Machine Learning, Main Challenges of Machine Learning, Testing and Validating.	2		
1.3	**End to End Machine Learning**: Working with Real Data	2		
1.4	Frame the Problem, Select the Performance Measure, Prepare the Data for ML Algorithms, Training and Evaluating the Data Set.	2		
1.5	**Bayesian Decision Theory**: Introduction, Classification.	2		
Module – 2: Classification and Training Models				
2.1	**Classification:** MNIST, Training Binary Classifier	2		
2.2	Performance Measures, Multiclass classification.	2		
2.3	**Training Models**: Linear Regression, Gradient Descent	2		
2.4	Regularized Linear Models – Ridge & Lasso Regression.	2		
Module – 3: Dimensionality Reduction and Support Vector Machines				
3.1	**Dimensionality Reduction**: The Curse of Dimensionality, Main Approaches for Dimensionality	2		
3.2	PCA, Linear Discriminant Analysis (LDA).	2		
3.3	**Support Vector Machines**: Linear SVM Classification, Nonlinear SVM	2		
3.4	VM Regression, Kernelized SVMs.	2		
Module – 4:Decision Trees				
4.1	**Decision Trees**: Univariate Trees: classification & Regression Trees, Training and Visualizing a Decision Tree	2		
4.2	Pruning, Rule Extraction from Trees, Learning Rules from Data, Making Predictions	2		
4.3	Estimating Class Probabilities, CART Training Algorithm, Computational Complexity	2		
4.4	Gini Impurity or Entropy? Regularization Hyperparameters, Multivariate Trees.	2		
Module – 5: Ensemble Learning and Unsupervised Learning				
5.1	**Ensemble Learning and Random Forests**: Voting Classifiers, Bagging and Pasting, Random Patches	2		
5.2	Random Subspaces, Random Forests, Boosting	2		

5.3	**Unsupervised Learning Techniques**: Clustering – K means, Spectral, Hierarchical	2		
	Total No. of Lecture Hours	**40**	**-**	**-**
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Introduction to Machine Learning, Ethem Alpaydin, PHI Learning Pvt. Ltd, 3rd Edition, 2018.
2. Hands-on machine learning with Scikit-Learn and TensorFlow: concepts, tools, and techniques to build intelligent systems, Aurelien Geron, O'Reilly Media, 2019.

Reference Book:

1. Machine Learning, Tom Mitchell, McGraw Hill, 2013.
2. Probability and Statistics for Computer Scientists, Michael Baron, 3rd Edition, CRC press, 2019.

Online Resources:

1. https://nptel.ac.in/courses/106106139
2. https://www.coursera.org/programs/faculty-learning-program-iqr5x/specializations/ibm-intro-machine-learning?source=search

Code: BCI613G **Course:Computer Vision**
Credits:3 **L:T:P - 3:0:0**
SEE: 100 Marks **CIE: 100 Marks**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Deep learning
Learning objectives	**Course objectives:** 1) To introduce the fundamental concepts, theories, and applications of computer vision. 2) To develop an understanding of image formation, processing, and classical vision algorithms for analysis and feature extraction. 3) To provide knowledge of deep learning architectures and their application to computer vision problems. 4) To enable students to apply transfer learning techniques for building efficient and practical vision-based solutions.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the principles of image formation, representation, and fundamental image processing operations in computer vision.	Understand
CO2	Apply classical image processing and segmentation techniques to extract features from digital images.	Apply
CO3	Analyze digital images using morphological image processing operations and various color image models.	Analyse
CO4	Develop and evaluate computer vision-based applications using Deep learning models.	Evaluate

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	1	2	-	-	-	-	-	-	-	2		2	1
CO2	3	3	2	2	2	-	-	-	2	2	2	3		3	2
CO3	3	3	3	2	3	-	-	-	2	3	3	3		3	3
CO4	3	3	3	3	3	2	2	2	3	3	3	3		3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1				
1.1	**Introduction:**Whatiscomputervision?, Brief History	2		
1.2	**ImageFormation:**Photometricimage formation	2		
1.3	The digital camera	1		
1.4	**Imageprocessing**: Point operators	1		
1.5	Linear filtering.	2		
Module – 2				
2.1	**Imageprocessing**: More neighborhood operators,	2		
2.2	Fourier transforms	2		
2.3	Pyramids and wavelets	2		
2.4	Geometrictransformations	2		
Module – 3				
3.1	**ImageSegmentation:**Fundamentals	1		
3.2	Point,Lineandedgedetection,	2		
3.3	Thresholding(Foundation&Basic global thresholding only)	1		
3.4	Segmentation by region growing & region splitting & merging.	2		
3.5	**Color Image Processing**: Color Fundamentals, Color Models.	2		
Module – 4				
4.1	Morphological Image Processing: Preliminaries	1		
4.2	Erosion and Dilation	2		
4.3	Opening and Closing	2		
4.4	Hit-or-Miss transform, some basic morphological algorithm	1		
4.5	**FeatureExtraction:**Background, Boundarypreprocessing(Boundaryfollowing&Chaincodesonly).	2		
Module – 5				
5.1	**Deep neural network for Computer Vision** : Convolutional Neural Network	2		
5.2	**Transfer learning:** Definition of Transfer learning	1		
5.3	Fundamental problems in Transfer learning, negative transfer learning,	1		
5.4	A complete transfer learning process.	2		
5.5	Pretraining and Fine-tuning. Transfer learning for computer vision.	2		

Total No. of Lecture Hours	**40**	**-**	**-**
Total No. of Tutorial Hours		**10**	**-**
Total No. of Practical Hours			**00**

Textbook:

1. RichardSzeliski,Computer Vision: Algorithms and Applications (Texts in Computer Science), 2nd Edition, 2022, Springer.
2. RafaelCG.,WoodsRE.andEddinsSL,DigitalImageProcessing,Pearson,4thedition,2019.
3. Jindong Wang and Yiqiang Chen, Introduction to Transfer Learning: Algorithms and Practice, 2023, Springer.

Referencebooks

1. DavidForsythandJeanPonce,ComputerVision:AModernApproach,2ndEdition,Pearson,2015.
2. ReinhardKlette,ConciseComputerVision-AnIntroductionintoTheoryandAlgorithms,Springer, 2014.

Code: BCI516B **Course: Information Retrieval**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Databases, Probability and Statistics.
Learning objectives	• Equip students with skills in various retrieval models and pre-processing techniques. • Enable students to design and optimize search systems for web and enterprise environments.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the components of information retrievalsystems, including models, data processing, retrievalchallenges, and search architectures.	Understand
CO2	Apply information retrieval models and pre-processing tomanage and retrieve structured and multimedia data usingenterprise and web search systems..	Apply
CO3	Analyze information retrieval models, pre-processingmethods, retrieval challenges, and search systemarchitectures and ranking techniques.	Analyze
CO4	Evaluate information retrieval models, pre-processingmethods, retrieval effectiveness, and search systemarchitectures.	Evaluate

Mapping with POs and PSOs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2		PSO 1	PSO 2
CO 1	3	3	2	2	-	2	3	-	-	-	-	-		2	2
CO 2	3	2	2	3	2	-	-	3	2	2	2	-		3	2
CO 3	3	2	3	2	2	2	3	-	2	3	2	-		3	2
CO 4	3	3	3	3	2	-	2	3	3	2	3	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction to Information Retrieval				
1.1	Information Vs Data Retrieval, Information Retrieval Models: Boolean Model	2	-	-
1.2	Vector Space Model, Language Model	2	-	-
1.3	Multimedia Retrieval, Probabilistic Model	2	-	-
1.4	Neural Network Model, Precision and Recall	2	-	-
Module – 2: Text and Webpage Pre-Processing				
2.1	Pre-processing Technique, Inverted index	2	-	-
2.2	Latent Semantic Indexing, Web Search	2	-	-
2.3	Simple Ranking Functions, Web Spamming	2	-	-
2.4	Managing Web Data	2	-	-
Module – 3: Structured Text Retrieval and Multimedia Information Retrieval				
3.1	Structuring Power, Explicit vs. Implicit Structure, Static vs. Dynamic Structure, Single Hierarchy vs. Multiple Hierarchies	2	-	-
3.2	Early Text Retrieval Models, Model Based on Non-Overlapping Lists, Model Based on Proximal Nodes, Ranking Structured Text Results	2	-	-
3.3	What is Multimedia? Multimedia IR,Text IR versus Multimedia IR, The Challenges, The Semantic Gap,Feature Ambiguity, Machine-generated Data	2	-	-
3.4	Content-based Image Retrieval, Color-Based Retrieval, Texture, Salient Points	2	-	-
Module – 4:Web Retrieval and Web Crawling				
4.1	Search Engine Architectures: Cluster based Architecture, Distributed Architectures	2	-	-
4.2	Search Engine Ranking: Link based Ranking, Simple Ranking Functions, Learning to Rank	2	-	-
4.3	Search Engine User Interaction	2	-	-
4.4	Browsing, Applications of a Web Crawler	2	-	-

Module – 5: Enterprise Search				
5.1	Characteristics and Applications of Enterprise Search, Enterprise Search Software, Workplace Search	2	-	-
5.2	Enterprise Search Tasks, Examples of Search-Supported Tasks, Search Types, Studying Enterprise Search	2	-	-
5.3	Architecture of Enterprise Search Systems, Gathering	2	-	-
5.4	Extracting, Indexing	2	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

Ricardo Baeza-Yates and Berthier Ribeiro-Neto, ―Modern Information Retrieval: The Concepts and Technology behind Search, Second Edition, ACM Press Books.
Ricci, F, Rokach, L. Shapira, B.Kantor, ―Recommender Systems Handbook, First Edition.

Reference Book:

C. Manning, P. Raghavan, and H. Schütze, ―Introduction to Information Retrieval, Cambridge University Press.
Stefan Buettcher, Charles L. A. Clarke and Gordon V. Cormack, ―Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press.

Online Resources:

1. Coursera Course Link: https://www.coursera.org/learn/text-retrieval

   YouTube Video Link: https://www.youtube.com/watch?v=Q72hzU1Z6aQ

Code: BCI516C **Course: Nonlinear Control Systems**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Mathematics, Basic Control Theory, Signals and Systems
Learning objectives	• Recognize and describe the fundamental characteristics of nonlinear systems, including common nonlinear phenomena such as multiple equilibria, limit cycles, and bifurcations. • Apply Lyapunov's direct method to assess the stability of nonlinear systems. Develop and use Lyapunov functions to determine stability and asymptotic stability.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain the basic concepts and characteristics of nonlinear dynamical systems, including equilibrium points, stability, and phase portraits.	Understand
CO2	Apply function analysis for studying the behavior of nonlinear systems under sinusoidal inputs.	Apply
CO3	Apply sliding mode control strategies to handle system uncertainties and achieve robust performance.	Apply
CO4	Analyze and design controllers for real-world nonlinear systems such as robotics, automotive systems, and aerospace applications	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	2	-	-	-	2	-	-	-	-	-	-		2	2
CO2	-	-	2	2	2	-	-	-	-	-	-	-		2	2
CO3	-	-	3	2	-	-	-	-	-	-	2	-		3	2
CO4	-	-	3	2	-	-	-	-	2	-	-	-		3	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction				
1.1	State-space representation of nonlinear systems - Basic characteristics of nonlinear systems.	3	-	-
1.2	Second Order Systems (Phase plane analysis) - Classification of equilibrium points - Systems with multiple equilibria - Analysis of piecewise linear control systems, Feedback systems in standard form, Classification of nonlinearities, Applications - Pulse control of spacecraft, Digital autopilot control of the Shuttle.	5	-	-
Module – 2: Describing function analysis				
2.1	The principle of harmonic balance - Describing functions for various nonlinearities.	4	-	-
2.2	Stability of limit cycles by describing function method, Limit cycle analysis of control systems.	4	-	-
Module – 3: Lyapunov Stability Theory				
3.1	Mathematical preliminaries - Linear vector spaces, Norms and inner products, Normed and inner product spaces. Nonlinear differential equations - Existence and uniqueness. Lyapunov's direct method - Definite functions, Stability and instability theorems.	4	-	-
3.2	Stability of linear systems - Lyapunov equation for time-invariant systems, Stability conditions for time varying systems, Lyapunov's linearization (indirect) method, Region of attraction. Frequency Domain Analysis of Feedback Systems - Absolute stability (Lure) problem, Kalman-Yakubovitch lemma, Circle criterion, Popov's theorem.	4	-	-
Module – 4: Nonlinear Control Design Methods				
4.1	Sliding Mode Control - Robust Control of Nonlinear Systems - Backstepping	4	-	-

4.2	Feedback Linearization - Lie derivatives and Lie brackets, Input-state linearization of SISO systems, Input-output linearization of SISO systems	4	-	-

Module – 5: Input-Output Stability				
5.1	Function spaces - Input-output stability - Small-gain theorem, Circle criterion	3	-	-
5.2	Passivity - Circle criterion, Popov criterion, Dissipativity - Storage Functions, Stability of dissipative systems, Control design using input-output methods	5	-	-
	Total No. of Lecture Hours	**40**	-	-
		Total No. of Tutorial Hours	**00**	**-**
			Total No. of Practical Hours	**00**

Textbook:

1. H. K. Khalil Nonlinear Systems, Third Edition, Prentice-Hall., 2002

Reference Book:

1. H. J. Marquez, Nonlinear Control Systems: Analysis and Design, John Wiley Interscience, 2003.
2. J. J. Slotine and W. Li Applied Nonlinear Control, Prentice-Hall, 1991.
3. M. Vidyasagar, Nonlinear Systems Analysis, SIAM, 2002
4. J. E. Gibson Nonlinear Automatic Control, McGraw-Hill,1963.
5. J. C. Hsu and A. V. Meyer Modern Control Principles and Applications, McGraw-Hill, 1968.

Code: BCI516D **Course: Image and Video Processing**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Signals and Systems, Digital Signal Processing
Learning objectives	• To teach students to design and implement efficient parallel algorithms using various computational models and architectures. • To enable students to apply parallel processing techniques to solve complex problems in computational geometry, graph theory, and numerical analysis.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain the basic fundamentals of digital image processing and Image Transforms	Understand
CO2	Demonstrate the Image Processing Techniques in Spatial Domain and Frequency Domain.	Apply
CO3	Illustrate the various Image compression models	Apply
CO4	Describe the Basic Steps of Video Processing`	Understand
CO5	Explore the Mathematical and computational skills needed to understand the principle of 2- D Motion Estimation	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	2	-	2	-	-	-	-	-	-	-		-	-
CO2	3	3	3	3	3	-	-	-	-	-	-	1		2	2
CO3	3	3	3	2	3	-	-	-	-	-	-	1		3	3
CO4	2	3	3	2	3	-	-	-	-	-	-	-		2	2
CO5	3	2	2	1	1	-	-	-	-	-	-	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction and Image Enhancement				
1.1	Fundamentals of Image Processing and Image Transforms:- Digital Image fundamentals, Sampling and quantization of an Image, Relationship between pixels	4	-	-
1.2	Image Transforms: 2-D Discrete Fourier Transform, Properties, Discrete cosine Transform, Hadamard Transform	4	-	-
Module – 2: **Image Restoration**				
2.1	Image Processing Techniques: Image Enhancement : Spatial Domain methods: Histogram Processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening Spatial filters.	4	-	-
2.2	Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening. Image Restoration: Degradation Model, Inverse Filtering, Least Mean Square Filters, Constrained Least Squares Restoration.	4	-	-
Module – 3: Image Compression				
3.1	Introduction, Need for image compression, Redundancy in images, Classification of redundancy in images, image compression scheme, Classification of image compression schemes.	4	-	-
3.2	Huffman coding, Arithmetic coding, Predictive coding, transformed based compression, Image compression standards, Wavelet-based image compression.	4	-	-
Module – 4: Basic Steps of Video Processing				
4.1	Analog video, Digital video, Time varying image formation model.	4	-	-
4.2	Geometric image formation, formation, sampling of video signal.	4	-	-
Module – 5: 2D Motion Estimation				
5.1	Optical flow, Pixel based motion estimation, Region based Motion estimation.	4	-	-

5.2	Multi resolution motion estimation, Application of motion estimation in video coding.	4	-	-
	Total No. of Lecture Hours	**40**	-	-
		Total No. of Tutorial Hours	**00**	-
			Total No. of Practical Hours	**00**

Textbook:

1. R.Gonzalez, R.E.Woods, “Digital Image Processing”, 3rd Edition, Pearson Education, India, 2009
2. M. Tekalp, “Digital Video Processing”, Prentice-Hall, 1995.

Reference Book:

1. Rafael C. Gonzalez, Richard E Woods and Steven L. Eddins, “Digital Image Processing using MAT LAB” , Pearson Edu., 2004.
2. Bovik, “Handbook of Image & Video Processing”, Academic Press, 2000
3. Yao Wang, JornOstermann and Ya Qin Zhang, “Video Processing and Communications”, Prentice Hall Publishers, 2002

Online Resources:

1. NPTEL Course Link: Digital Image Processing - Course (nptel.ac.in)

Code: BCI516E **Course: Pervasive computing**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Computer networks
Learning objectives	• To understand the Pervasive computing, applications and device technology. • To introduce the web applications, WAP and voice technology in computing.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Expolre the applications in the area of Pervasive Computing.	Understand
CO2	Describe the device connectivity and web application concepts in pervasive computing.	Understand
CO3	Explain the Wireless application protocol and voice technology	Understand
CO4	Describe different digital assistants	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12		PSO 1	PSO 2
CO1	2	-	3	-	2	-	-	-	-	-	-	-		-	-
CO2	2	2	2	-	2	-	-	-	-	-	-	-		2	2
CO3	2	2	3	2	3	-	-	-	-	-	-	-		2	2
CO4	2	-	3	2	3	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.no	Modules -1: Pervasive computing Application	No. of Lecture Hours
1.1	**Past, Present, future**- The vine and fig tree dreams.	1
1.2	The pervasive computing.	1
1.3	The pervasive computing market, m-Business, challenges.	2
1.4	**Application:** retail, Airline check-in booking.	2
1.5	Sales force automation, healthcare	1
1.6	Tracking, car information systems, Email access via and voice.	1

	Modules -2: Device Technology and connectivity	
2.1	**Device Technology**- hardware, human machine interfaces.	1
2.2	Biometric, Operating systems.	1
2.3	Java for pervasive devices.	1
2.4	**Device connectivity**: protocols, security	1
2.5	Device management	1
	Modules -3: Web Application concepts	
3.1	**Web application concepts:** History of world wide web	1
3.2	World wide web architecture	2
3.3	Protocols, Transcoding	2
3.4	Client authentication via internet	2
	Module -4 WAP and beyond: Introduction component of the WAP architecture.	
4.1	**WAP and beyond**: Introduction component of the WAP architecture.	1
4.2	WAP infrastructure	1
4.3	WAP security issues	3
4.4	Wireless Markup Language	2
4.5	WAP push, products, i-Mode	2
4.6	**Voice technology**: Basics of speech recognition	1
4.7	Voice standards, Speech applications	1
4.8	Speech and pervasive computing and security.	1
	Module -5 Personal digital assistants	
5.1	History	1
5.2	Device categories, Personal digital assistant operating systems	2
5.3	Devise characteristics, Software components, standards	2
5.4	Mobile applications, Personal digital assistant browsers	2
	Total No. of Lecture Hours	40

Textbook:

1. Jochen Burkhardt, Horst Henn, Stefan Hepper, Klaus Rindtorff and Thomas schaeck Pervasive Computing Technology and Architecture of Mobile Internet Applications, Addision Wesley, Reading, 2002.
2. Uwe Ha nsman, Lothat Merk, Martin S Nicklous & Thomas Stober, Principles of Mobile Computing, Second Edition, Springer- Verlag, New Delhi, 2003. Reference Books

Reference Book:

1. Rahul Banerjee: Internetworking Technologies: An Engineering Perspective, Prentice – Hall of India, New Delhi, 2003. (ISBN 81-203- 2185-5)
2. Rahul Banerjee: Lecture Notes in Pervasive Computing, Outline Notes, BITS-Pilani, 2003.

Code: BCI586 **Course: Minor Project**

Credits: 1 **L:T:P:0:0:2**

CIE: 50 Marks **Max. Marks: 50**

Prerequisites if any	Form a team , Project objectives, Literature survey, identify resources, define Methodology, documentation.
Learning objectives	Clearly state the goals and objectives of the project. Determine the scope and expected outcomes. Collaborate with classmates for the project teamwork. Assign roles and responsibilities based on each team members strengths. Identify potential risks and challenges that might arise during the project. Maintain detailed records of your project , design, and development process. Prepare to present your findings and results clearly and comprehensively.

Course Outcomes:

On the successful completion of the course ,the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Conceptualize, design and implement solutions for specific problems	Apply
CO2	Apply resource management skills for projects and Communicate the solutions through presentations and technical reports	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	-	2	3	1	2	1	1	-	-	-	-	-		2	2
CO2	-	-	-	-	-	-	1	1	1	1	1	2		2	2

Mapping Strength: **Strong–3** **Medium–2** **Low –1**

Course Code: BRMCS557 **Course name: Research Methodology and IPR**

Credits: 02 **L:T:P - 2:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 2 **Max. Marks:100**

Prerequisites if any	NIL
Learning objectives	1. To gain knowledge on research methodology and explain the technique of formulating a research problem. 2. To understand various research designs and different types of data collections. 3. To understand various sampling designs and its characteristics. 4. To acquire the knowledge on report writing and various concepts of IPR.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Discuss different objectives of research and formulating Research Problem	Understand
CO2	Apply various research design and methods of data collection	Apply
CO3	Analyze various sampling design and its characteristics	Analyze
CO4	Demonstrate the knowledge on Report Writing and IPR	Evaluate

Mapping with POs and PSOs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2		PSO 1	PSO 2
CO 1	3	3	3	2	2	-	3	2	-	-	2	3		3	2
CO 2	3	2	3	2	2	2	-	2	2	-	2	3		3	-
CO 3	3	2	3	2	3	2	2	-	2	-	2	3		3	-
CO 4	3	3	2	2	2	2	3	3	2	2	2	2		2	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Research Methodology: An Introduction, Defining the research problem				
1.1	Meaning of Research, Objectives of Research Motivation in Research	1	-	-
1.2	Types of Research, Research Approaches, Research Methods versus Methodology, Research and Scientific Method.	2	-	-
1.3	Research Process.	3	-	-
1.4	Criteria of good research, what is a Research Problem?	1	-	-
1.5	Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.	2	-	-
Module – 2: Research Design, Methods of data collection				
2.1	Meaning of Research, Design, Need for Research Design	1	-	-
2.2	Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs.	2	-	-
2.3	Collection of Primary Data, Observation Method, Interview Method Collection of Data through Questionnaires.	3	-	-
2.4	Collection of Data through Schedules, Difference between Questionnaires and Schedules ,Some Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection	3	-	-
Module – 3: Report Writing and Introduction to Intellectual Property				
3.1	Significance of Report Writing, Different Steps in Writing Report,Layout of the Research Report, Types of Reports, Types of Reports, Precautions for Writing Research Reports, Conclusions	1	-	-
3.2	Role of IP in the Economic and Cultural Development of the Society, IP Governance, Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention, Rights Associated with Patents, Enforcement of Patent Rights, Inventions Eligible for Patenting, Process of Patenting	4	-	-
3.3	Classes of Copyrights, Criteria for Copyright Ownership of Copyright, Copyrights of the Author, Copyright Infringements, Copyright Registration, Copyright Symbol Validity of Copyright.	2	-	-
	Total No. of Lecture Hours	**25**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Kothari, C.R., (2014), Research Methodology, New Age International second revised edition
2. Prof. Rupinder Tewari, Ms. Mamta Bhardwaj (2021) Intellectual Property A Primer for Academia.

Reference Book:

1. Ranjit Kumar, (2011). Research Methodology a step by step guide for beginners, Sage Publications
2. Chawla, Deepak &Sondhi, Neena (2011). Research methodology: Concepts and Cases, Vikas Publishing House Pvt. Ltd. Delhi.

Online Resources:

1. https://onlinecourses.swayam2.ac.in/cec23_ge07/preview
2. https://onlinecourses.nptel.ac.in/noc22_ge08/preview

The National Institute of Engineering

Scheme of Teaching & Examination (2022 Scheme)

Department: Computer Science and Engineering (BE in CS&E (AI and ML))

B.E. 2023 Admitted Batch

VI Semester

Sl.No	Type of Course	Course Code	Course Title	Teaching Department (TD)	Question Paper setting Board (PSB)	Teaching Hrs/Week				Examination				Credits
						L	T	P	S	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	IPCC	BCO601	Microcontroller and Embedded Systems	CS	CS	3	0	2		3	50	50	100	**4**
2	PCC	BCI602	Deep Learning	CS	CS	3	0	0		3	50	50	100	**3**
3	PEC	BCI613x	Professional Elective Course - Group II	CS	CS	3	0	0		3	50	50	100	**3**
4	OEC	BCI654x	Open Elective Course - Group I	CS	CS	3	0	0		3	50	50	100	**3**
5	PCC	BCI605	Information & Network Security	CS	CS	4	0	0		3	50	50	100	**4**
6	PCC	BCI606	Data Mining	CS	CS	3	0	0		3	50	50	100	**3**
7	PCCL	BCIL607	Deep Learning Algorithms Lab	CS	CS	0	0	2		2	50	50	100	**1**
8	AEC/SDC	BCI657X	Ability Enhancement Course / Skill Development Course V	CS	CS	If the course is a Theory: 1	0	0		1	50	50	100	**1**
						OR								
						If the course is a Laboratory: 0	0	2		2				
9	MC	BNSK658	National Service Scheme (NSS)	NSS Coordinator		0	0	2		_	100	_	100	**0**
		BPEK658	Physical Education (PE) (Sports & Athletics)	PED										
		BYOK658	Yoga	Yoga Teacher										
		BMUK658	Music	Music Teacher										
10	MC	BIKK259	Indian Knowledge Systems	Humanities		1	0	0	0	0	50	-	50	**0**
										Total	**500**	**400**	**900**	**22**

Professional Elective Course - Group II

BCI613A	Human Computer Interface	BCI613D	Time Series Analysis
BCI613B	Cloud Computing	BCI613E	Pattern Recognition
BCI613C	Blockchain Technology	BCI613F	Ensemble Methods

Open Elective Course - Group I

BCI654A	Introduction to Data Structures	BCI654D	Introduction to AI
BCI654B	Fundamentals of Operating Systems		
BCI654C	Introduction to Mobile Application Development		

Ability Enhancement Course / Skill Enhancement Course-V

BCIL657A	Explainable AI	BCSL657D	DevOps
BCIL657B	PyTorch		

Course Code: BCO601 **Course: Microcontroller and Embedded Systems**

Credits: 4 **L:T:P:S 3:0:2**

CIE: 25 **SEE: 100**

SEE Hours: 3 **Max. Marks: 100**

Course Outcomes:

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

COs	Course Outcomes	Bloom's level
CO1	Describe the architectural features and instruction set of 32 bit ARM microcontrollers.	Understand
CO2	Apply instructions of assembly language for programming ARM.	Apply
CO3	Interpret the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.	Apply
CO4	Explain the need of real time operating system for embedded system applications.	Understand
CO5	Develop/test/Conduct the experiments on an ARM7TDMI/LPC2148 evaluation board using Embedded 'C' and Keil Vision tool/Compiler	Apply

Mapping with POs and PSOs:

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	-	-	-	-	-	-	1	-	-	-	-		2	2
CO2	-	3	3	3	3	3	2	-	1	-	3	-		3	3
CO3	3	2	-	-	2	-	-	-	-	-	-	-		2	2
CO4	3	3	3	3	3	2	2	-	-	-	-	-		2	2
CO5	3										3			3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

	Module – 1 -	No. of Lecture Hours	No. of Tutorial Hours	Self Learning Hours
1.1	Microprocessors versus Microcontrollers, ARM Embedded Systems: The RISC design philosophy, The ARM Design Philosophy,	2	-	-
1.2	Embedded System Hardware, Embedded System Software,	2	-	-
1.3	ARM Processor Fundamentals: Registers, Current Program Status Register,	2	-	-
1.4	Pipeline, Exceptions, Interrupts, and the Vector Table , Core Extensions.	2	-	-
	Module – 2 -		-	-
2.1	Introduction to the ARM Instruction Set : Data Processing Instructions ,	2	-	-
2.2	Programme Instructions, Software Interrupt Instructions,	2	-	-
2.3	Program Status Register Instructions, Coprocessor Instructions, Loading Constants	2	-	-
2.4	ARM programming using Assembly language: Writing Assembly code, Profiling and cycle counting, instruction scheduling,	2		
2.5	Register Allocation, Conditional Execution, Looping Constructs.	2		
	Module – 3 –		-	-
3.1	Embedded Vs General computing system, History of embedded systems, Classification of Embedded systems,	2	-	-
3.2	Major applications areas of embedded systems, purpose of embedded systems Core of an Embedded System including all types of processor/controller,	2	-	-
3.3	Memory, Sensors, Actuators, LED, 7 segment LED display,	2	-	-
3.4	Stepper motor, Keyboard, Push button switch.	2		
	Module – 4 –		-	-
4.1	Characteristics and Quality Attributes of Embedded Systems,	2	-	-
4.2	Operational quality attributes, nonoperational quality attributes,	2	-	-
4.3	Embedded Systems-Application and Domain specific	2	-	-
4.4	Hardware Software Co-Design and Program Modelling.	1	-	-
	Module – 5 –		-	-
5.1	Operating System basics, Types of operating systems,	2	-	-

5.2	Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Multiprocessing and Multitasking, Task Communication (without any program),	2	-	-
5.3	Task synchronization issues – Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program),	2	-	-
5.4	How to choose an RTOS, Integration and testing of Embedded hardware and firmware.	1	-	-
	Total No. of Lecture Hours	40		
	Total No. of Tutorial Hours		0	
	Total No. of Self learning Hours			0

Text Books:

1. Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide, Elsevier, Morgan Kaufman publishers, 2008.
2. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education, Private Limited, 2 nd Edition.

Reference Books:

1. Raghunandan..G.H, Microcontroller (ARM) and Embedded System, Cengage learning Publication,2019
2. The Insider's Guide to the ARM7 Based Microcontrollers, Hitex Ltd.,1st edition, 2005.
3. Steve Furber, ARM System-on-Chip Architecture, Second Edition, Pearson, 2015.
4. Raj Kamal, Embedded System, Tata McGraw-Hill Publishers, 2nd Edition, 2008.

Online Resources:

1. https://www.coursera.org/specializations/cortex-m-architecture-and-software-development
2. https://www.coursera.org/programs/faculty-learning-program-iqr5x/learn/introduction-embedded-systems?source=search

Lab Experiments – 15 Hours

Conduct the following experiments by writing programs using ARM7TDMI/LPC2148 using an evaluation board/simulator/evaluation version of Embedded 'C' & Keil Uvision-4 tool/compiler. and the required software tool.

1. Develop a program to multiply two 16 bit binary numbers.
2. Write a program to find the sum of first 10 integer numbers.
3. Write a program to find factorial of a number.
4. Write a program to add an array of 16 bit numbers and store the 32 bit result in internal RAM
5. Write a program to find the square of a number (1 to 10) using look-up table.
6. Write a program to find the largest/smallest number in an array of 32 numbers .
7. Display "Hello World" message using Internal UART.
8. Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction
9. Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in between
10. Interface a 4x4 keyboard and display the key code on an LCD.

Code: BCI602 **Course: DEEP LEARNING**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Basic understanding of calculus, linear algebra, and programming concepts in Python.
Learning objectives	• Implement diverse deep learning architectures effectively for various data modalities and tasks. • Critically evaluate and apply regularization and optimization techniques in deep learning models. • Demonstrate proficiency in deploying and fine-tuning deep learning models for real-world applications.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Describe the fundamentals of deep learning, including network architectures and backpropagation algorithms.	Understand
CO2	Demonstrate the use of recurrent and convolutional neural networks for modeling sequential and image data.	Apply
CO3	Examine deep learning techniques, including regularization and ensemble methods, for solving real-world challenges in data analysis.	Analyze
CO4	Assess autoencoders with respect to their principles, implementation, and applications.	Evaluate

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	2	1	2	2	1	1	1	2	2	1		2	2
CO2	3	2	1	2	3	2	1	1	2	2	1		2	2
CO3	3	3	3	3	2	2	1	1	2	2	1		2	3
CO4	3	2	2	3	3	2	1	1	2	2	1		2	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

SL No	Module Name's	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Neural Networks			
1.1	**Neural Networks:** What is a neural network, Models of a Neuron, Activation functions, Network Architectures, Knowledge representation, Learning Process.	4		
1.2	**Deep Feedforward Networks:** Multilayer Perceptron, Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation Algorithm	4		
	Module – 2: Regularization for Deep Learning			
2.1	Parameter Norm Penalties - L2 Parameter Regularization, Dataset Augmentation, Semi-Supervised Learning	4		
2.2	Optimization for Training Deep Models: Challenges in Neural Network Optimization – Ill Conditioning, Local Minima, Plateaus, Saddle Points.	4		
	Module – 3: Convolutional Networks			
3.1	**Convolutional Networks:** Convolution Operation, Motivation, Pooling,Convolution and Pooling as an Infinitely Strong Prior, Variants of the basic convolution function, Structured Outputs	4		
3.2	Data types, Efficient Convolution Algorithms, Random or Unsupervised features, The Neuroscientific basis for convolutional networks.	4		
	Module – 4: Sequence Modelling			
4.1	Recurrent and Recursive Nets: Unfolding Computational Graphs, RecurrentNeural Networks, Bidirectional RNNs,	3		
4.2	Encoder-Decoder Sequence-to-Sequence Architectures, DeepRecurrent Networks, Recursive Neural Networks	2		
4.3	Echo State Networks, The Long Short-Term Memoryand Other Gated RNNs	3		
	Module – 5:Autoencoders			
5.1	Undercomplete Autoencoders, Regularized Autoencoders, Representational Power	3s		
5.2	Layer Size and Depth, Stochastic Encoders and Decoders, DenoisingAutoencoders	3		
5.3	Contractive Auto encoders, Applications of Auto encoders	2		

Total No. of Lecture Hours	**40**	**-**	**-**
Total No. of Tutorial Hours		**00**	**-**
Total No. of Practical Hours			**00**

Textbook:

1. Simon Haykin, Neural networks and Learning Machines, Third Edition, Pearson, 2016
2. *Deep Learning*, Ian Goodfellow, YoshuaBengio, Aaron Courville, MIT press, 2016.

Reference Book:

1. *Pattern Recognition and Machine Learning*, Christopher M. Bishop, Springer, 2006
2. Neural Networks: A Systematic Introduction, Raul Rojas, Springer, 1996.
3. *Machine Learning: A Probabilistic Perspective*, Kevin P. Murphy, MIT Press, 2012

Online Resources:

1. https://nptel.ac.in/courses/106106184

Code: BCI613A **Course: Human Computer Interface**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	NIL
Learning objectives	• To Demonstrate the knowledge of HCI , its principles , planning and designing. • To Design windows and evaluate HCI patterns for different applications.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain HCI and principles to interaction design.	Understand
CO2	Apply different screen planning and screen design techniques.	Apply
CO3	Design Windows and conduct HCI patterns evaluation.	Apply
CO4	Design tools for blind or PH people.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	1	-	2	-	2	-	-	-	-	-	-	-		-	-
CO2	2	1	2	-	2	-	-	-	-	-	-	-		-	2
CO3	2	1	2	-	3	-	-	-	-	-	-	-		2	-
CO4	2	2	2	-	3	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction				
1.1	Importance of user Interface	1		
1.2	Importance of good design	1		
1.3	Brief history of Screen Design	1		
1.4	The graphical user interface	1		
1.5	Web user –Interface	1		
1.6	Web user –Interface popularity	1		
1.7	Principles of user interface	1		
Module – 2: Design process – Human interface with computers				
2.1	Importance of human characteristics	1		
2.2	Human interaction speeds	1		
2.3	Screen Designing	1		
2.4	Screen navigation and flow	1		
2.5	Visually pleasing	1		
2.6	Information retrieval on web	1		
2.7	Statistical graphics	1		
2.8	Technological consideration in interface design	1		
Module – 3: Windows				
3.1	New and Navigation schemes	2		
3.2	Selection of window	1		
3.3	Selection of devices based and screen	1		
3.4	Components – text and messages	1		
3.5	Icons and increases	1		
3.6	Multimedia	1		
3.7	Choosing colors	1		

Module – 4:HCI in the software process				
4.1	The software life cycle	2		
4.2	Design Focus	3		
4.3	Universal design principles Multi-modal interaction	3		
Module – 5:Cognitive models Goal and task				
5.1	GOMS saves money Linguistic models	1		
5.2	The challenge of display-based systems	1		
5.3	Computing applications research Design Focus	1		
5.4	Augmenting the physical Virtual and augmented reality Design Focus	1		
5.5	Design Focus	2		
5.6	Information and data visualization	3		
Total No. of Lecture Hours		**40**	**-**	**-**
		Total No. of Tutorial Hours	**00**	**-**
			Total No. of Practical Hours	**00**

Textbook:

1. The essential guide to user interface design, Wilbert O Galitz, Wiley Dream Tech. Units 1, 2, 3
2. Human – Computer Interaction. Alan Dix, Janet Fincay, GreGoryd, Abowd, Russell Bealg, Pearson Education Units 4,5

Reference Book:

1. Designing the user interface. 3rd Edition Ben Shneidermann, Pearson Education Asia.
2. Interaction Design Prece, Rogers, Sharps. Wiley Dreamtech.
3. User Interface Design, Soren Lauesen , Pearson Education.
4. Human –Computer Interaction, D. R. Olsen, Cengage Learning.
5. Human –Computer Interaction, Smith - Atakan, Cengage Learning.

Code: BCI613B **Course: Cloud computing**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Basics of Operating Systems and Computer networks.
Learning objectives	• Understanding of virtual machines (VMs) and how they work. • Understanding of Cloud Service Models - Knowledge of different cloud service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS).

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Identify the open-source platforms for private clouds, service – level and Compliance – level agreements, and software licensing.	Apply
CO2	Describe the data management and analytics in the cloud.	Understand
CO3	Explain cloud service models and their applications.	Understand
CO4	design and deploy scalable and secure cloud-based solutions.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-		-	-
CO2	3	3	-	-	3	-	-	-	-	-	-	-		-	2
CO3	3	3	2	2	3	-	-	-	-	-	-	-		2	2
CO4	3	3	2	-	3	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.no	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction to Cloud Computing				
1.1	Introduction: Network-centric computing and network-centric content, Peer-to-peer systems, Cloud computing – an old idea whose time has come, Cloud computing delivery models and services, Ethical issues in cloud computing, Cloud vulnerabilities, Major challenges faced by cloud computing.	4	-	-
1.2	Cloud Infrastructure: Cloud Computing at Amazon, Cloud Computing: The Google Perspective, Microsoft Windows Azure and Online Services, Open-Source Software Platforms for Private Clouds, Cloud Storage Diversity and Vendor Lock- in, Cloud Computing Interoperability: The Intercloud, Energy Use and Ecological Impact of Large-Scale Data Centers.	5	-	-
Module – 2: Cloud Computing				
2.1	Cloud Computing: Applications and Paradigms, Challenges for Cloud Computing, Existing Cloud Applications and New Application Opportunities, Architectural Styles for Cloud Applications.	4	-	-
2.2	Workflows: Coordination of Multiple Activities, Coordination Based on a State Machine Model: The ZooKeeper, The Map Reduce Programming Model. A Case Study: The Grep The Web Application, Clouds for Science and Engineering, High Performance Computing on a Cloud, Cloud Computing for Biology Research.	5	-	-
Module – 3: Cloud Resource Virtualization				
3.1	Cloud Resource Virtualization: Virtualization, Layering and Virtualization, Virtual Machine Monitors, Virtual Machines, Performance and Security Isolation, Full Virtualization and Para virtualization, Hardware Support for Virtualization.	4	-	-

3.2	Case Study: Xen, a VMM Based on Para virtualization, Optimization of Network Virtualization in Xen 2.0, vBlades: Para virtualization Targeting an x86-64 Itanium Processor, A Performance Comparison of Virtual Machines.	4	-	-

Module – 4: Cloud Resource Management and Scheduling				
4.1	Cloud Resource Management and Scheduling: Policies and Mechanisms for Resource Management, Applications of Control Theory to Task Scheduling on a Cloud, Stability of a Two-Level Resource Allocation Architecture, Feedback Control Based on Dynamic Thresholds, Coordination of Specialized Autonomic Performance Managers, A Utility- Based Model for Cloud-Based Web Services.	5	-	-
4.2	Resource Bundling: Combinatorial Auctions for Cloud Resources, Scheduling Algorithms for Computing Clouds, Fair Queuing, Start-Time Fair Queuing, Borrowed Virtual Time, Cloud Scheduling Subject to Deadlines, Scheduling Map Reduce Applications Subject to Deadlines.	4	-	-
Module – 5: Cloud Security				
5.1	Cloud Security: Cloud Security Risks, Security: The Top Concern for Cloud Users, Privacy and Privacy, Trust, Operating System Security, Virtual Machine Security, Security of Virtualization, Security Risks Posed by Shared Images, Security Risks Posed by a Management OS.	5	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Cloud Computing: Theory and Practice, Author (s): Dan C. Marinescu, Morgan Kaufmann Publication Year: 2013.

Reference Book:

1 Cloud Computing Bible Author(s): Barrie Sosinsky Publication Year: 27 December 2010.

2. Cloud Security: A Comprehensive Guide to Secure Cloud Computing Author(s): Ronald L. Krutz, Russell Dean Vines Publication Year: September

Code: BCI613C **Course: Blockchain Technology**

Credits: 3 **L:T:P 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Distributed systems ,computer networks, Cryptography
Learning objectives	· **Understand the fundamentals** of blockchain, distributed systems, and supply chain management concepts. · **Explain** the architecture, consensus mechanisms, cryptographic primitives, and decentralized systems supporting blockchain. · **Illustrate** the working of Bitcoin, Ethereum, Smart Contracts, and Hyperledger with their components. · **Apply** blockchain concepts to calculate the fees related to transactions. · **Analyze** the benefits, limitations, and real-world applications of blockchain in finance, supply chain, and other domains.

Course Outcomes: *On the successful completion of the course, the student will be able to*

CO1	Explain the architecture, components, and technical foundations of blockchain technology,	Understand
CO2	Apply blockchain decentralization and cryptographic techniques to analyze decentralized ecosystems, Smart Contracts, and digital signatures.	Apply
CO3	Analyze the structure and functioning of Bitcoin and Ethereum transactions, different applications of smart contracts , EVM and Consensus.	Analyze
CO4	Analyze the architecture and protocols of enterprise blockchain platforms, including Hyperledger Fabric, Sawtooth Lake, and Corda.	Analyze
CO5	Evaluate various blockchain platforms, consensus mechanisms, and decentralized frameworks by comparing their performance, scalability, and applicability to real-world domains such as finance, supply chain, governance and Healthcare.	Evaluate

Mapping with POs and PSOs:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2			2			2		2		2		2	2
CO2	3	3	2	2	3			2				2		2	2
CO3	3	3	2	2	3				2	2	2	3		2	2
CO4	3	3	3		3	2			2	2	3	3		2	2
CO5	3	3	2	2	3	2	2	2	2	2	2	3		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Introduction to Blockchain			
1.1	Introduction to Supply chain management system, importance of blockchain	1		
1.2	Distributed systems, CAP theorem, Byzantine Generals problem, Consensus. The history of blockchain	1		
1.3	Introduction to blockchain, Various technical definitions of blockchains, Generic elements of a blockchain, Features of a blockchain,	1		
1.4	Applications of blockchain technology, Tiers of blockchain technology.	1		
1.5	Consensus in blockchain, CAP theorem and blockchain,	1		
1.6	Benefits and limitations of blockchain	1		
	Module – 2: Decentralized System, & Cryptography primitives			
2.1	Decentralization using blockchain, Methods of decentralization	1		
2.2	Blockchain and full ecosystem decentralization, Smart contract, Decentralized organizations	1		
2.3	Decentralized autonomous organizations, Decentralized autonomous corporations, Decentralized autonomous societies. Decentralized applications, Platforms for decentralization	2		

2.4	Cryptographic primitives: Symmetric cryptography	1		
2.5	Asymmetric cryptography	1		
2.6	Public and private keys,	1		
2.7	Hash functions: Compression of arbitrary messages into fixed length digest, Easy to compute, Pre-image resistance, Second pre-image resistance, Collision resistance	1		
2.8	Message Digest (MD),Secure Hash Algorithms (SHAs), Merkle trees	1		
2.9	Patricia trees, Distributed hash tables (DHTs), Digital signatures	2		
2.10	Elliptic Curve Digital signature algorithm (ECDSA)	1		
		12		
Module – 3: Bitcoin and Smart Contract				
3.1	Bitcoin, Bitcoin definition, Transactions	1		
3.2	The transaction life cycle, The transaction structure, Types of transaction,	2		
3.3	The structure of a block, The structure of a block header	1		
3.4	The genesis block, The bitcoin network, Wallets	1		
3.5	Smart Contracts-History, Definition, Ricardian contracts	1		
3.6	Smart contract templates, Oracles	1		
3.7	Smart Oracles, Deploying smart contracts on a blockchain	1		
3.8	The DAO	1		
3.9	Overview of bitcoin explorer	1		
		10		
Module – 4 Ethereum				
4.1	Ethereum 101, Introduction, Ethereum clients and releases, The Ethereum stack,.	1		
4.2	Ethereum blockchain, Currency (ETH and ETC), Forks, Gas, The consensus mechanism,	1		
4.3	The world state, Transactions, Contract creation transaction, Message call transaction	2		
4.4	Elements of the Ethereum blockchain , Ethereum virtual machine (EVM), Accounts, Block,	2		

4.5	Ether, Messages, Mining, The Ethereum network	1		
4.6	Hands-on: Clients and wallets –Geth	1		
		8		
Module 5:				
5.1	Hyperledger, Hyperledger as a protocol,	1		
5.2	Fabric, Hyperledger Fabric	2		
5.3	Sawtooth lake, Corda.	1		
		6		
Total No. of Lecture Hours		**40**	**-**	**-**
Total No. of Tutorial Hours			**00**	**-**
Total No. of Practical Hours				**00**

Textbook:

1. Imran Bashir. “MastringBlockChain”, Third Edition, Packt – 2020.
2. Blockchain Technology: Concepts and Applications, by Kumar Saurabh & Ashutosh Saxena, WILEY Emerging Technology Series, First Edition, 2020

Reference Book:

1. Andreas M. , Mastering Bitcoin: Programming the Open Blockchain – O’rielly – 2017
2. Blockchain from concepts to execution, Debajani Mohanty, Second revised edition, BPB Publication, 2021
3. A Practical Guide To Blockchain And Its Applications , PARIKSHIT JAIN ,BloomsBury,Edition 2019

Online Resources:

1. https://nptel.ac.in/courses/106104220
2. https://www.geeksforgeeks.org/blockchain/
3. https://www.tutorialspoint.com/blockchain/index.htm
4. https://onlinecourses.nptel.ac.in/noc22_cs44/ -
5.
6. https://www.youtube.com/watch?v=qOVAbKKSH10, Blockchain Technology Explained (2 Hour Course)

Code:BCI613D **Course: Time Series Analysis**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Basics of probability and statistics
Learning objectives	• Introduces the concepts and methods of time-series analysis. • Foundational to modeling uncertainties, • Developing models from data and multivariate data analysis.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Discuss the concepts and methods of time-series analysis	Understand
CO2	Apply the proficiency in Time Series Modelling and Prediction	Apply
CO3	Illustrate Fourier Analysis and Spectral Methods	Apply
CO4	Analyze Practical Estimation and Case Studies	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-		2	2
CO2	2	3	3	-	3	-	-	-	-	-	-	-		2	2
CO3	2	3	-	3	3	-	-	-	-	-	-	-		2	2
CO4	2	3	3	-	-	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction to Time Series				
1.1	Introduction & Overview;	2	-	-
1.2	Review of Probability & Statistics	2	-	-
1.3	Introduction to Random Processes	2	-	-
1.4	Stationary Models and the Autocorrelation Function	2		
Module – 2: Stationary Processes				
2.1	Basic Properties, Linear Processes, Introduction to ARMA Processes	2	-	-
2.2	Properties of the Sample Mean and Autocorrelation Function	2	-	-
2.3	The Durbin–Levinson Algorithm, The Innovations Algorithm	2	-	-
2.4	Prediction of a Stationary Process in Terms of Infinitely Many Past Values	2	-	-
Module – 3: Nonstationary Time Series Models				
3.1	Models for Linear Nonstationary processes	2	-	-
3.2	Trends, Heteroskedasticity	2	-	-
3.3	ARIMA Models	2	-	-
3.4	Multivariate Time Series, Multivariate ARMA Processes	2	-	-
Module – 4: Fourier analysis and Spectral densities & Representation				
4.1	Fourier analysis of deterministic signals	2	-	-
4.2	DFT and periodogram	2	-	-
4.3	Spectral densities and representations; Wiener-Khinchin theorem	2	-	-
4.4	Harmonic processes; SARIMA models	2	-	-
Module – 5: Statistical Complements				
5.1	Least Squares Estimation	2	-	-
5.2	Maximum Likelihood and Bayesian estimators.	2	-	-
5.3	Estimation of signal properties, time-series models	2	-	-

5.4	Case studies	2	-	-
	Total No. of Lecture Hours	**40**	-	-
		Total No. of Tutorial Hours	**00**	-
			Total No. of Practical Hours	**00**

Textbook:

1. P. J. Brockwell and R.A. Davis, Introduction to Time Series and Forecasting, 2nd Edition, Springer, 2002.
2. T. W. Anderson, The Statistical Analysis of Time Series. Vol. 19, 1st Edition, John Wiley & Sons, 2011..

Reference Book:

1. P. J. Brockwell and R.A. Davis, Time Series: Theory and Methods, 2nd Edition, Springer Science & Business Media, 2009.
2. J. D. Hamilton, Time Series Analysis, 1st Edition, Princeton University Press. 2020.

Online Resources:

1. https://archive.nptel.ac.in/courses/103/106/103106123/

Code: BCI613E **Course: Pattern Recognition**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 03 **Max. Marks: 100**

Prerequisites if any	NIL
Learning objectives	Develop the ability to effectively implement and apply diverse pattern matching algorithms to analyze and recognize patterns within different types of data structures and domains

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Outline basic concepts of pattern recognition.	Understand
CO2	Classify decision-making algorithms in pattern recognition	Analyze
CO3	Apply Hierarchical and Partition clustering techniques in pattern recognition applications	Apply
CO4	Analyze feature selection algorithms in pattern recognition	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		1	1
CO2	2	3	2	-	-	-	-	-	-	-	-	-		2	2
CO3	3	2	2	2	2	-	-	-	-	-	-	-		2	2
CO4	2	2	-	2	2	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	Introduction: Basic concepts, Applications	1		
1.2	Fundamental problems in pattern Recognition system design	1		
1.3	Design concepts and methodologies	2		
1.4	Simple pattern recognition model.	1		
	Module – 2			
2.1	Statistical Decision Making: Introduction	1		
2.2	Baye's theorem	1		
2.3	Multiple features, Conditionally independent features	2		
2.4	Decision boundaries, Unequal cost of error, estimation of error rates	2		
2.5	The leaving-one-out-techniques	1		
2.6	characteristic curves	1		
2.7	estimating the composition of populations	1		
	Module – 3			
3.1	Non Parametric Decision Making: Histogram,	1		
3.2	kernel and window estimation,	2		
3.3	Nearest neighbour classification techniques.	1		
3.4	Adaptive decision boundaries, adaptive discriminant functions	2		
3.5	Minimum squared error discriminant functions	1		
3.6	choosing a decision making techniques	1		
	Module – 4			
4.1	Clustering and Partitioning: Hierarchical Clustering: Introduction,	1		
4.2	Agglomerative clustering algorithm,	1		
4.3	The single linkage, complete-linkage and average-linkage algorithm.	3		
4.4	Ward's method Partition clustering - Forg's algorithm, K-means's algorithm,	3		

4.5	Isodata algorithm.	1		
Module – 5				
5.1	Pattern Pre-Processing and Feature Selection: Introduction,	1		
5.2	Distance measures, clustering transformation and feature ordering,	3		
5.3	Clustering in feature selection through entropy minimization,	1		
5.4	Features selection through orthogonal expansion,	1		
5.5	Binary feature selection,	1		
5.6	Applications of Pattern Recognition in bio-metric, facial recognition, Finger prints, etc	2		
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Gose. Johnsonbaugh, Jost. Pattern recognition and Image Analysis, PHI. 1996
2. Tou. Rafael. Gonzalez. Pattern Recognition Principle, Pearson Education. 1975

Reference Book:

1. Richard duda, Hart., David Strok, Pattern Classification, John Wiley ,2nd Edition 2000.

2. Theodoridis, S. and K. Koutroumbas, Pattern recognition, 4th Ed. 2009, San Diego, CA: Academic Press.

Online Resources:

1. https://nptel.ac.in/courses/117105101
https://www.coursera.org/specializations/machine-learning-introduction?action=enroll

Code: BCI613F **Course: Ensemble Methods**

Credits: 3 **L:T:P– 3: 0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	**NIL**
Learning objectives	To gain proficiency in Machine learning models, Neural networks to solve problems. To gain knowledge of Stacked generalization and perform exploratory analysis.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Describe the principles and algorithms behind various machinelearning models and neural networks.	Understand
CO2	Implement machine learning models and neural networks to solve real- world problems.	Apply
CO3	Analyze and interpret the predictive performance of machine learning models and neural networks	Apply
CO4	Explain the concept of stacked generalization and its use in improving model accuracy.	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		2	2
CO2	2	2	3	3	2	-	-	-	-	-	-	-		2	2
CO3	2	3	2	-	3	-	-	-	-	-	-	-		2	3
CO4	3	2	2	2	2	-	-	-	-	-	-	-		3	3

Mapping Strength: **Strong– 3 Medium – 2 Low – 1**

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction				
1.1	Ensemble learning	1		
1.2	Ensemble techniques	1		
1.3	Advanced ensemble techniques	1		
1.4	Algorithms based on bagging and boosting	1		
1.5	Bagging meta estimator	1		
1.6	Random Forest	1		
1.7	Gradient Boosting(GBM)	1		
Module – 2: Methods for constructing ensembles				
2.1	Bayesian Voting	1		
2.2	Enumerating the hypotheses	1		
2.3	Manipulating the training examples	2		
2.4	Manipulating the input features	1		
2.5	Manipulating the output targets	1		
2.6	Injecting randomness	1		
2.7	Markov chain	1		
2.8	Bayesian ensembles	1		
Module – 3: Techniques of classifiers				
3.1	Bayes optimal classifier	1		
3.2	Booststrap aggregating	1		
3.3	Bayesian model combination	1		
3.4	Bayesian model averaging	1		
3.5	Bucket of models	1		
3.6	Amended cross-Entropy	1		
3.7	Stacking	1		

Module – 4: Ensemble Techniques				
4.1	Max Voting	2		
4.2	Averaging	3		
4.3	Weighted Averaging	3		
Module – 5: Applications				
5.1	Classification tasks	1		
5.2	Regression Problems	1		
5.3	Detection	1		
5.4	Anomaly Detection	1		
5.5	NLP	2		
5.6	Ensemble regression	3		
	Total No. of Lecture Hours	**40**	**-**	**-**
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Text book:

1. Hands-On Ensemble Learning with Python, 2019.

Reference Book:

1. Supervised and Unsupervised Ensemble Methods and their Applications, 2008.

2. Pattern Classification Using Ensemble Methods, 2010.

Code: BC1654A **Course: Introduction to Data Structures**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Problem Solving through Programming
Learning objectives	• To provide the knowledge to explain the fundamentals of data structures and their applications essential for problem solving. • To acquire the knowledge on applying the concepts of Stack, Queue, Linked lists, trees and sorting algorithms for solving the real-world problems.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain the concepts of pointers and structures in problem solving.	Understand
CO2	Use different types of linked lists to solve problems.	Apply
CO3	Demonstrate stack and queue data structures to solve problems.	Apply
CO4	Illustrate the operations performed on tree data structure and different sorting methods	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	2		-	-
CO2	3	2	3	-	-	-	-	-	-	-	-	2		3	3
CO3	3	2	3	-	-	-	-	-	-	-	-	2		3	3
CO4	3	2	3	-	-	-	-	-	-	-	-	2		3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	Pointers: Introduction	1	-	-
1.2	Structures, Nested Structures, Arrays of Structures	2	-	-
1.3	Structures and Functions, Self-Referential Structures	2	-	-
1.4	Introduction to Data Structures, Classification of data structures, Operations on data structures, Abstract data type	1	-	-
	Module – 2			
2.1	Linked Lists - Singly linked lists	3	-	-
2.2	Circular linked lists	2	-	-
2.3	Doubly linked lists	2		
2.4	Circular doubly linked lists	2		
	Module – 3			
3.1	Stacks: Introduction, Array Representation of Stacks	1	-	-
3.2	Operations on a Stack, Linked Representation of Stacks	1	-	-
3.3	Applications of Stacks: Conversion of an infix expression into a postfix expression, Evaluation of a postfix expression, Recursion.	3	-	-
3.4	Queues: Introduction, Array Representation of Queues, Linked Representation of Queues	2	-	-
3.5	Types Of Queues: Circular Queue, Priority Queues	2	-	-
	Module – 4			
4.1	Trees: Introduction, Types of Trees	1	-	-
4.2	Traversing A Binary Tree,	1	-	-
4.3	Binary Search Trees, Operations on Binary Search Trees	3	-	-
4.4	Threaded Binary Trees: One-way Threading,	1	-	-
4.5	AVL Tree,Binary Heaps operations	3	-	-
	Module – 5			
5.1	Sorting: Introduction to Sorting , Radix Sort , Heap Sort	2	-	-

5.2	Hashing and Collision: Introduction, Hash Tables, Different Hash Functions	2	-	-
5.3	Collisions	2	-	-
5.4	Pros and Cons of Hashing, Applications of Hashing	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. ReemaThareja, ―Data Structures using C‖, 2nd Edition, 2018, Oxford University Press.

Reference Book:

1. Aaron M Tenenbaum, YedidyahLangsam and Moshe J Augenstein, ―Data StructuresusingC , 2014, low price edition, Pearson education,.
2. Richar F Gilberg and BehronzA Forouzan, ―Data Structures, A Pseudocode Approach with C, 2nd Edition, 2012, Thomson.
3. Horowitz, Sahni, Anderson-Freed, ―Fundamentals of Data Structures in C, 2nd Edition, 2011, Universities Press.

Online Resources:

1. NPTEL: Programming and Data structures- https://nptel.ac.in/courses/106/105/106105085/
2. Coursera: Data Structures - https://www.coursera.org/learn/data-structures
3. Programming & Data structures: http://nptel.ac.in/courses/106106130

Code: BCI654B **Course: Fundamentals of Operating Systems**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	C Programming, Data Structures, Object Oriented Programming, Computer Organization
Learning objectives	• To Obtain awareness on concepts of operating systems and structures. • To Understand and implement the concept of Process and threads. • To Demonstrate the common synchronization problems arising in the Operating systems and provide solutions to them • To Demonstrate the issue of deadlock and handle them effectively. • To Understand the concept of Memory and demonstrate its management using various strategies. • To Know the various storage mechanisms available and discuss the management of storage space.

Course Outcomes: *On the successful completion of the course, the student will be able to*

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain the structure and functions of operating system.	Understand
CO2	Demonstrate the concepts of Process synchronization and Identify root causes of deadlock to provide the solution for deadlock elimination.	Apply
CO3	Explore the concept of memory management, working of various page replacement algorithms and file system operations	Apply
CO4	Describe the mass storage structure and Demonstrate file system implementation	Understand
CO5	Explain the concept of Virtual Machines, Virtualization, file protection methods and Mobile OS.	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	1	3	2	-	-	-	-	-	-	-	-		-	-
CO2	2	2	2	2	2	-	-	-	-	-	-	-		2	2
CO3	2	3	3	3	2	-	-	-	-	-	-	-		2	2
CO4	2	2	2	3	-	-	-	-	-	-	-	-		-	-
CO5	2	2	3	2	3	-	-	-	-	-	-	-		3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Introduction			
1.1	Computer System - Elements and organization; Operating System Overview - Objectives and Functions - Evolution of Operating System	3	-	-
1.2	Operating System Structures – Operating System Services - User Operating System Interface - System Calls – System Programs - Design and Implementation - Structuring methods.	5	-	-
	Module – 2: Process Management			
2.1	Processes - Process Concept - Process Scheduling - Operations on Processes – Inter process Communication; CPU Scheduling - Scheduling criteria - Scheduling algorithms.	3	-	-
2.2	Threads - Multithread Models – Threading issues; Process Synchronization - The Critical-Section problem - Synchronization hardware – Semaphores – Mutex - Classical problems of synchronization - Monitors; Deadlock - Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock	5	-	-
	Module – 3: Memory Management			
3.1	Main Memory - Swapping - Contiguous Memory Allocation – Paging - Structure of the Page Table - Segmentation, Segmentation with paging	4	-	-
3.2	Virtual Memory - Demand Paging – Copy on Write - Page Replacement - Allocation of Frames –Thrashing	4	-	-
	Module – 4: Storage Management			
4.1	Mass Storage system – Disk Structure - Disk Scheduling and Management; File-System Interface - File concept - Access methods - Directory Structure - Directory organization - File system mounting - File Sharing and Protection	4	-	-
4.2	File System Implementation - File System Structure - Directory implementation - Allocation Methods - Free Space Management; I/O Systems – I/O Hardware, Application I/O interface, Kernel I/O subsystem.	4	-	-

Module – 5: Virtual Machines, File Protection and Mobile OS				
5.1	Virtual Machines – History, Benefits and Features, Building Blocks, Types of Virtual Machines and their Implementations, Virtualization and Operating-System Components	3	-	-
5.2	Protection: Goals, Principles and Domains of protection, Access matrix, Implementation of access matrix, Revocation of access rights, Access control, Mobile OS - iOS and Android.	5	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, ―Operating System Concepts‖, 10th Edition, John Wiley and Sons Inc., 2018.
2. Andrew S Tanenbaum, "Modern Operating Systems", Pearson, 5th Edition, 2022 New Delhi..

Reference Book:

1. RamazElmasri, A. Gil Carrick, David Levine, ― Operating Systems – A Spiral Approach‖, Tata McGraw Hill Edition, 2010.
2. William Stallings, "Operating Systems: Internals and Design Principles", 7th Edition, Prentice Hall, 2018.
3. AchyutS.Godbole, AtulKahate, McGraw Hill Education, 2016.

Online Resources:

1. https://www.geeksforgeeks.org/operating-systems/
2. https://www.youtube.com/watch?v=RozoeWzT7IM&list=PLdo5W4Nhv31a5ucW_S1K3-x6ztBRD-PNa
3. https://en.wikipedia.org/wiki/Operating_system
4. https://www.youtube.com/watch?v=By6lWjiPpVI&list=PLG9aCp4uE-s17rFjWM8KchGlffXgOzzVP
5. https://www.youtube.com/watch?v=bkSWJJZNgf8&list=PLxCzCOWd7aiGz9donHRrE9I3Mwn6XdP8

Code: BCI654C **Course: Introduction to Mobile Application Development**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 03 **Max. Marks: 100**

Prerequisites if any	Java
Learning objectives	• Learn to setup Android application development environment • Illustrate user interfaces for interacting with apps and triggering actions • Interpret tasks used in handling multiple activities • Identify options to save persistent application data • Appraise the role of security and performance in Android applications

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Create, test and debug Android application by setting up Android development environment.	Understand
CO2	Implement adaptive, responsive user interfaces that work across a wide range of devices	Analyze
CO3	Demonstrate methods in storing, sharing and retrieving data in Android applications	Apply
CO4	Analyze performance of android applications and understand the role of permissions and security	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2		3	-	3	-	-	-	-	-	-	-		2	2
CO2		3	3	-	3	-	-	-	-	-	-	-		2	2
CO3	3		3	-	3	-	-	-	-	-	-	-		2	2
CO4		2	3	-	2	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1				
1.1	Get started	1		
1.2	Build your first app	2		
1.3	Activities	2		
1.4	Testing, debugging and using support libraries	3		
Module – 2				
2.1	User Interaction	3		
2.2	Delightful user experience	3		
2.3	Testing your UI	2		
Module – 3				
3.1	Background Tasks	3		
3.2	Triggering	3		
3.3	Scheduling and optimizing background tasks	2		
Module – 4				
4.1	All about data	1		
4.2	Preferences and Settings	2		
4.3	Storing data using SQLite	2		
4.4	Sharing datawith content providers	2		
4.5	Loading data using Loaders	1		
Module – 5				
5.1	Permissions	2		
5.2	Performance and Security	3		
5.3	Firebase and AdMob	2		
5.4	Publish	1		
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Google Developer Training, "Android Developer Fundamentals Course – ConceptReference", Google Developer Training Team, 2017.

Reference Book:

1. Erik Hellman, "Android Programming – Pushing the Limits", 1st Edition, Wiley IndiaPvt Ltd, 2014.

2. Dawn Griffiths and David Griffiths, "Head First Android Development", 1st Edition,O'Reilly SPD Publishers, 2015.

3. J F DiMarzio, "Beginning Android Programming with Android Studio", 4th Edition,Wiley India Pvt Ltd, 2016.

4. Anubhav Pradhan, Anil V Deshpande, " Composing Mobile Apps" using Android,Wiley 2014.

Online Resources:

1. https://www.gitbook.com/book/google-developer-training/android-developerfundamentals-course-concepts/details

Code: BCl654D **Course: Introduction to AI**

Credits: 3 **L:T:P: 3:0: 0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Probability , Statistics and Linear Algebra
Learning objectives	To gain insights on different concepts and methods used in Artificial intelligence to solve real world problems.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain Artificial Intelligence concepts and methods.	Understand
CO2	Use knowledge representation to solve real world problems	Apply
CO3	Use neural networks to solve real world problems	Apply
CO4	Solve problems using classification and clustering techniques.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		-	-
CO2	2	2	3	-	3	-	-	-	-	-	-	-		3	2
CO3	2	3	3	-	3	-	-	-	-	-	-	-		2	3
CO4	3	3	3	-	3	-	-	-	-	-	-	-		2	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Introduction			
1.1	Introduction	1		
1.2	Characteristics	1		
1.3	Exhaustive Searches	1		
1.4	Heuristic Search Techniques	1		
1.5	Interative Deepening	1		
1.6	Constant satisfaction	1		
1.7	General problem solving	1		
	Module – 2: Problem reduction and Logic concepts			
2.1	Bounded look ahead strategy	1		
2.2	Alpha-Beta Pruning	1		
2.3	Propositional calculus	1		
2.4	Propositional logic	1		
2.5	Natural Deduction system	1		
2.6	Axiomatic system	1		
2.7	Semantic tableau system in propositional logic	1		
2.8	resolution refutation in propositional logic and Predicate logic	2		
	Module – 3: Advanced problem-solving paradigm			
3.1	Planning- types of planning systems	2		
3.2	Linear planning using a goal stack	1		
3.3	Non –linear planning strategies	1		
3.4	Means-ends analysis	1		
3.5	Knowledge representation using semantic network	1		
3.6	Extended semantic networks for KR	1		
3.7	Knowledge representation using frames	1		

Module – 4: Uncertainty Measure				
4.1	Probability Theory	2		
4.2	Bayesian Belief Networks	3		
4.3	Machine Learning Paradigms	3		
Module – 5: Support vector Machine, case-based reasoning and learning ANN				
5.1	Single Layer and Multilayer	1		
5.2	RBF	1		
5.3	Design issues in ANN	1		
5.4	Recurrent Network	1		
5.5	Deductive learning,	2		
5.6	Clustering	2		
	Total No. of Lecture Hours	**40**		
	Total No. of Tutorial Hours		**00**	
	Total No. of Practical Hours			**00**

Textbook:

1. Artificial Intelligence, Saroj Kaushik Cengage Learning 2014 Editio

Reference Book:

1. Artificial Intelligence: Structures and Strategies for Complex Problem Solving, George F Luger Pearson Addison Wesley 6 th Ed, 2008.
2. Artificial Intelligence, E Rich, K Knight, and S B Nair Tata Mc-Graw Hill 3rd Ed, 2009.
3. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig Prentice Hall 3rd, 2009

Code:BCI605 **Course: Information and Network Security**

Credits: 4 credits **L:T:P – 4:0:0**

SEE:100 Marks **CIE:50 Marks**

SEE Hours: 3 hours **Max. Marks:100**

Prerequisites if any	
Learning objectives	1. Understand the basics of Cryptography concepts, Security and its principle 2. To analyse different Cryptographic Algorithms 3. To illustrate public and private key cryptography 4. To understand the key distribution scenario and certification 5. To understand approaches and techniques to build protection mechanism in order to secure computer networks

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course outcomes	Bloom's level
CO1	Explain the principles of cryptography, security services, and network protection mechanisms.	Understand
CO2	Apply symmetric and asymmetric cryptographic algorithms for secure communication.	Apply
CO3	Analyze authentication methods, key management, and access control techniques in network security.	Analyze
CO4	Evaluate email, web, and IP security mechanisms to recommend suitable solutions for different scenarios.	Evaluate

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	3	1	3	-	-	1	-	-	-	2		3	2
CO2	3	3	3	3	3	-	-	1	-	-	1	2		3	2
CO3	2	3	3	3	3	-	-	2	-	-	1	2		3	1
CO4	2	3	3	3	2	-	-	2	-	-	-	3		3	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl No.	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Classical Encryption Techniques			
1.1	A model for Network Security	1	-	-
1.2	Classical encryption techniques: Symmetric cipher model	1	-	-
1.3	Substitution ciphers-Caesar Cipher	1	-	-
1.4	Monoalphabetic Cipher	1	-	-
1.5	Playfair Cipher	1	-	-
1.6	Hill Cipher	1	-	-
1.7	Polyalphabetic Ciphers.	1		
1.8	One time pad	1		
1.9	Block Ciphers and Data Encryption Standards: Traditional Block Cipher structures, data Encryption Standard (DES)	2		
	Module – 2: Public Key Cryptography and RSA			
2.1	Principles of public key cryptosystems-Public key cryptosystems	1	-	-
2.2	Applications for public key cryptosystems	1	-	-
2.3	Requirements for public key cryptography, Public key Cryptanalysis	1	-	-
2.4	The RSA algorithm: Description of the Algorithm, Computational aspects, The Security of RSA.	2	-	-
2.5	Diffie-Hellman key exchange: The Algorithm,Analog of Diffie-Hellman key Exchange, Key exchange Protocols	2	-	-
2.6	Elgamal Cryptographic system	1	-	-
2.7	Elliptic Curve Cryptography: Elliptic Curve Encryption/Decryption .	1	-	-
2.8	Security of Elliptic Curve Cryptography.	1		
	Module – 3: Key Management and Distribution			
3.1	**Symmetric key distribution using symmetric encryption :** A Key Distribution Scenario Hierarchical Key Control Session Key Lifetime A Transparent Key Control Scheme Decentralized Key Control Controlling Key Usage	3	-	-

3.2	**Symmetric key distribution using asymmetric encryption:** Simple Secret Key Distribution Secret Key Distribution with Confidentiality and Authentication A Hybrid Scheme	3		
3.3	**Distribution of public keys:** Public Announcement of Public Keys Publicly Available Directory Public-Key Authority Public-Key Certificates	2	-	-
3.4	**X.509 Certificates:** Certificates X.509 Version 3	2	-	-
	Module – 4: User Authentication			
4.1	Remote user-Authentication principles: Mutual Authentication ,One-Way Authentication	1	-	-
4.2	Remote user authentication using symmetric encryption: Mutual Authentication ,One-Way Authentication	1		
4.3	Kerberos: Kerberos Version 4 Kerberos Version 5	2	-	-
4.4	Remote user authentication using asymmetric encryption:Mutual Authentication ,One-Way Authentication	1	-	-
4.5	Web security consideration: Web Security Threats Web Traffic Security Approaches	1		
	Transport Layer Security : Version Number Message Authentication Code Pseudorandom Function Alert Codes Cipher Suites Client Certificate Types Certificate_Verify and Finished Messages Cryptographic	2		
4.6	Email Threats and comprehensive email security, S/MIME, Pretty Good Privacy.	2		

Module – 5: Internet Security and Electronic Mail Security				
5.1	Domain keys Identified Mail.	2	-	-
5.2	IP Security: IP Security overview	2	-	-
5.3	IP Security Policy	2	-	-
5.4	Encapsulating Security Payload	2	-	-
5.5	Combining security associations	1	-	-
5.6	Internet key exchange	1		
	Total No. of Lecture Hours	**50**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

William Stallings, "Cryptography and Network Security", Pearson Publication, Seventh Edition.

Reference Book:

1. Keith M Martin, "Everyday Cryptography", Oxford University Press
2. V.K Pachghare, "Cryptography and Network Security", PHI, 2nd Edition

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs90/preview

Code: BCI606 **Course: Data Mining**

Credits: 3 **L:T:P - 3:0:0**

SEE: 50 Marks **CIE: 50 Marks**

SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Databases, Statistics and Probability.
Learning objectives	• Develop proficiency in fundamental data mining techniques, including pattern mining, classification, clustering, and outlier analysis, to extract valuable insights from diverse data sets. • Gain expertise in data preprocessing methods, such as data cleaning, integration, normalization, and discretization, to ensure high-quality data for effective mining and analysis.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the fundamental concepts, techniques, and applications of data mining including pattern discovery, classification, clustering, and outlier analysis.	Understand
CO2	Apply data cleaning, integration, normalization, and discretization techniques to prepare data for mining.	Apply
CO3	Analyze different datasets using suitable data mining methods (Apriori, decision trees, k-means, DBSCAN) and interpret the discovered knowledge for real-world applications.	Analyze
CO4	Evaluate the effectiveness, accuracy, and limitations of various data mining techniques by comparing algorithmic performance and assessing their applicability to diverse domains.	Evaluate

Mapping with POs and PSOs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2		PSO 1	PSO 2
CO 1	2	2	1	1	2	-	-	-	-	1	-	1		1	2
CO 2	3	3	3	2	3	-	-	-	1	1	1	1		1	2
CO 3	3	3	3	3	3	1	-	1	1	2	-	2		2	3
CO 4	3	3	2	2	3	1	-	1	1	1	1	3		3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction				
1.1	Introduction: What is data mining? Data mining: an essential step in knowledge discovery; Diversity of data types for data mining; Mining various kinds of knowledge – Multidimensional data summarization, Mining frequent patterns, associations, and correlations, Classification and regression for predictive analysis, Cluster analysis, Deep learning, Outlier analysis, Are all mining results interesting?	4	-	-
1.2	Data mining: confluence of multiple disciplines – Statistics and datamining, Machine learning and data mining, Data base technology and data mining, Data mining and data science, Data mining and other disciplines; Data mining and applications.	4	-	-
Module – 2: Data, Measurements, and Data Pre-processing				
2.1	Data, measurements, and data pre-processing: Data types – Nominal attributes, Binary attributes, Ordinal attributes, Numeric attributes, Discrete vs. continuous attributes; Statistics ofdata – Measuring the central tendency, Measuring the dispersion of data.	3	-	-
2.2	Similarity and distance measures- Data matrix vs. dissimilarity matrix, Proximity measures for nominal attributes, Proximity measures for binary attributes, Dissimilarity of numeric data : Minkowski distance	3	-	-
2.3	Data quality, data cleaning, and data integration – Data quality measures, Data cleaning, Data integration; Data transformation – Normalization, Discretization.	2	-	-
Module – 3: Pattern Mining				
3.1	Pattern mining: basic concepts and methods: Basic concepts-Market basket analysis: motivating example, Frequent item sets, closed item sets, and association rules.	3	-	-
3.2	Frequent item set mining methods – Apriori algorithm: finding frequent item sets by confined candidate Generation, Generating association rules from frequent item sets, Improving the efficiency of Apriori.	3	-	-
3.3	A pattern-growth approach for mining frequent item sets, Mining frequent item sets using the vertical data format.	2	-	-

Module – 4: Classification				
4.1	Classification: basic concepts and methods: Basic concepts – What is classification, General approach to classification; Decision tree induction – Decision tree induction, Attribute selection measures, Tree pruning.	5	-	-
4.2	Bayes classification methods - Bayes' theorem, Naïve Bayesian classification; Lazy learners- k-nearest-neighbor classifiers.	3	-	-
Module – 5: Cluster Analysis				
5.1	Cluster analysis: basic concepts and methods: Cluster analysis – What is cluster analysis? Requirements for cluster analysis, Overview of basic clustering methods.	3	-	-
5.2	Partitioning methods - kMeans: a centroid-based technique, Variations of k-means; Hierarchical methods – Basic concepts of hierarchical clustering, Agglomerative hierarchical clustering, Divisive hierarchical clustering	4	-	-
5.3	Density-based and grid-based methods - DBSCAN: density – based clustering based on connected regions with High density.	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Jiawei Han, Jian Pei, Hanghang Tong, "Data Mining Concepts and Techniques",4th Edition, 2022, Elsevier, MK Publishers.

Reference Book:

1. Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, "Introduction to DataMining.

Online Resources:

1. NPTEL Course Link: https://onlinecourses.nptel.ac.in/noc21_cs06/preview
MITOpenCourseWare Link: https://ocw.mit.edu/courses/15-062-data-mining-spring-2003/

Deep Learning Algorithms Lab			
Course Code	**BCIL607**	CIE Marks	50
Teaching Hours/Week(L: T:P)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	2
Examination type(SEE)	Practical		

Course outcomes:

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

1. Illustrate the fundamental components of neural networks and analyze their basic architectures through practical experiments.
2. Design, implement, and train deep feedforward and convolutional neural networks for solving real-world problems.
3. Develop and evaluate recurrent and sequence-to-sequence models for various sequence prediction applications.
4. Construct and analyze different types of autoencoders, demonstrating their applications in representation learning.

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	2	1	2	2	1	1	1	2	2	1		2	2
CO2	3	2	1	2	3	2	1	1	2	2	1		2	2
CO3	3	3	3	3	2	2	1	1	2	2	1		2	3
CO4	3	2	2	3	3	2	1	1	2	2	1		2	3

Mapping Srength: Strong– 3 Medium – 2 Low – 1

Sl No	CO's	Experiments
1	CO1	**Basic Neural Networks** **Objective**: Implement basic neural network components. **Tasks**: Write a Python program to create and train a simple neural network from scratch using NumPy. This includes implementing models of neurons, activation functions, and basic network architecture.
2	CO1 & CO2	**Deep Feedforward Networks** **Objective**: Implement a multilayer perceptron (MLP) and train it using the back-propagation algorithm. **Tasks**: Train an MLP on the XOR problem, and demonstrate gradient-based learning and the use of hidden units.

3	CO2	**Convolutional Neural Networks (CNN) Basics** **Objective**: Implement a simple CNN for image classification. **Tasks**: Write a Python program to build a CNN for the MNIST dataset, including convolution and pooling layers.
4	CO2	**Advanced Convolutional Networks** **Objective**: Explore different variants of convolution functions and pooling operations. **Tasks**: Implement and compare different CNN architectures using various convolution and pooling techniques. Experiment with efficient convolution algorithms and random features.
5	CO3	**Recurrent Neural Networks (RNN)** **Objective**: Implement and train a basic RNN for sequence modeling. **Tasks**: Write a Python program to build an RNN for text generation or sequence prediction, using unfolding computational graphs.
6	CO3	**Sequence-to-Sequence Models** **Objective**: Implement encoder-decoder architecture for sequence-to-sequence tasks. **Tasks**: Train a sequence-to-sequence model for machine translation or text summarization using bidirectional RNNs and deep recurrent networks.
7	CO3	**Long Short-Term Memory (LSTM) Networks** **Objective**: Implement LSTM networks and explore their benefits over standard RNNs. **Tasks**: Build and train an LSTM network for a time series prediction problem, comparing it with Echo State Networks and other gated RNNs.
8	CO4	**Autoencoders** **Objective**: Implement different types of autoencoders. **Tasks**: Write Python programs to build and train undercomplete, denoising, and variational autoencoders on image data. Explore regularization techniques and representational power.

Textbook

1. Neural networks and Learning Machines, Simon Haykin, Third Edition, Pearson, 2016

2. Deep Learning by Ian Goodfellow, YoshuaBengio, and Aaron Courville:

Additional Online Resources:

1. Coursera - Deep Learning Specialization by Andrew Ng

Code: BCIL657A **Course: Explainable AI**

Credits: 1 **L:T:P - 1:0:0**

SEE: NA **CIE:50 Marks**

SEE Hours: NA **Max. Marks:50**

Prerequisites if any	NIL
Learning objectives	• To familiarize concepts related to Explainable Artificial Intelligence (XAI) and interpretable methods, with emphasis on how to build a trustworthy AI system. • To understand the performance of a machine learning model and its ability to produce explainable and interpret able predictions.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain the methods and terminologies involved in Explainable AI	Understand
CO2	Apply suitable XAI Models or approaches for given application.	Apply
CO3	Analyze the methods used in XAI	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	-	2	3	2	-	-	-	-	-	-	-		-	-
CO2	3	-	2	3	3	-	-	-	-	-	-	-		-	-
CO3	3	-	2	3	3	-	-	-	-	-	-	-		-	-

Mapping Strength: Stron3g– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction to Explainable Artificial Intelligence				
1.1	Fundamentals of XAI ,Categorization of XAI	1	-	-
1.2	Taxonomy of XAI methods for Machine Learning.	1	-	-
1.3	Machine Learning Interpretability , Causal Model Induction	1	-	-
1.4	Causality learning	1		
1.5	XAI techniques and limitations.	1		
Module – 2: XAI Models				
2.1	Ante-hoc Explainability (AHE) models	1	-	-
2.2	Post-hoc Explainability (PHE) models	1	-	-
2.3	Interactive Machine Learning (IML)	1	-	-
2.4	Black Box Explanation through Transparent Approximation (BETA) models	1	-	-
2.5	Hybrid Models	1		
Module – 3: XAI Methods				
3.1	XAI Techniques - Local Interpretable Model-Agnostic Explanations (LIME)	1	-	-
3.2	Understanding Mathematical representation of LIME - Shapley Additive exPlanations (SHAP)	2	-	-
3.3	Diverse Counterfactual Explanations (DiCE)	1	-	-
3.4	Layer wise Relevance Propagation (LRP).	1	-	-
	Total No. of Lecture Hours	**15**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Molnar, Christoph. “Interpretable machine learning.A Guide for Making Black Box Models Explainable”, 2019.https://christophm.github.io/interpretable-ml-book/

2. Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning, UdayKamath: John Liu, Springer, ISBN 9783030833558

Reference Book:

1. Tim Miller Explanation in Artificial Intelligence: https://arxiv.org/abs/1706.07269 Insight from Social Science,
2. A Guide for making black-boxhttps://christophm.github.io/interpretable-ml-book/
3. Explainable AI: A Review of Machine Learning Interpretability Methods https://www.mdpi.com/1099-4300/23/1/18
4. Lötsch, J.; Kringel, D.; Ultsch, A. Explainable Artificial Intelligence (XAI) in Biomedicine: Making AI Decisions Trustworthy for Physicians and Patients. BioMedInformatics 2022, 2, 1-17 https://doi.org/10.3390/biomedinformatics2010001

Code: BCIL657B **Course: PyTorch**

Credits: 1 **L:T:P–1:0:0**

SEE: NA **CIE:50 Marks**

SEE Hours: NA **Max. Marks:50**

Prerequisites if any	Basics of Python
Learning objectives	• Explain the differences and similarities between PyTorch and other deep learning frameworks like TensorFlow. • Understand what tensors are and how they generalize matrices to higher dimensions and its broadcasting methods.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain the differences and similarities between PyTorch and other deep learning frameworks like TensorFlow.	Understand
CO2	Use PyTorch for research , production and solve real world problems.	Apply
CO3	Use tensors to generalize matrices of higher dimensions and broadcasting method to simplify operations.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	3	2	-	-	-	-	-	-	-		2	3
CO2	3	3	-	3	3	-	-	-	-	-	-	-		2	-
CO3	3	3	-	2	3	-	-	-	-	-	-	-		3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introducing deep learningand the PyTorch library				
1.1	What is PyTorch, Why PyTorch -The deep learning revolution, Immediate versus deferred execution, The deep learning competitive landscape.	2	-	-
1.2	PyTorch has the batteries included - Hardware for deep learning, Using Jupyter Notebooks.	3	-	-
Module – 2: Tensors				
2.1	Tensor fundamentals - Tensors and storages - Size, storage offset, and strides - Numeric types.	3	-	-
2.2	Indexing tensors – NumPy interoperability - Serializing tensors - Moving tensors to the GPU - The tensor API	3	-	-
Module – 3: Real-world data representation with tensors				
3.1	Tabular data - Time series – Text	2	-	-
3.2	Text embeddings, Images - Volumetric data.	2	-	-
	Total No. of Lecture Hours	**15**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Deep Learning with PyTorch Essential Excerpts Eli Stevens and Luca Antiga, 2019
2. Deep Learning for Coders with Fastai and PyTorch: AI Applications Without a PhD, by Jeremy Howard (Author), Sylvain Gugger (Author), 16 July 2023

Code: BCSL657D **Course: DevOps**

Credits: 1 **L:T:P - 1:0:0**

SEE: NA **CIE: 50 Marks**

SEE Hours: NA **Max. Marks:50**

Prerequisites if any	--NIL--
Learning objectives	• understanding of DevOps principles, tools, and practices. • to effectively collaborate in a DevOps environment, automate processes, and manage infrastructure as code.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	**Course Outcomes**	**Bloom's level**
CO1	Explain the core concepts, principles, and benefits of DevOps.	Understand
CO2	Demonstrate Proficiency in using version control systems and implementing collaborative development workflows.	Apply
CO3	Demonstrate Skill in provisioning and managing infrastructure using Infrastructure as Code (IaC) tools.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	-	2	-	2	-	-	-	-	-	-	-		-	-
CO2	-	-	3	-	3	-	-	-	-	-	-	-		2	3
CO3	-	3	3	-	3	-	-	-	-	-	-	-		3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl.No	Module	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction to Devops and its Principles				
1.1	Introduction to DevOps and its Principles: Understanding DevOps: Definition, goals, and benefits	1	-	-
1.2	Key principles of DevOps: Continuous integration, continuous delivery, automation, and collaboration	1		
1.3	DevOps culture and mindset, Case studies of successful DevOps implementations.	1		
1.4	Version Control and Collaboration Tools: Introduction to version control systems (e.g., Git)	1		
1.5	Branching and merging strategies, Collaborative development workflows, Introduction to code review processes and tools (e.g., GitHub, Bitbucket)	1		
Module – 2: Continuous Integration and Build Automation				
2.1	Continuous integration (CI) concepts and benefits	1	-	-
2.2	Introduction to build automation tools (e.g., Jenkins, Travis CI)	1	-	-
2.3	Configuring and managing CI pipelines, running automated tests and generating reports	1	-	-
2.4	Infrastructure as Code (IaC): Introduction to Infrastructure as Code (IaC) and its benefits	1	-	-
2.5	Infrastructure provisioning tools (e.g., Terraform, CloudFormation) , Building and managing infrastructure using IaC	1	-	-
Module – 3: Configuration Management				
3.1	Introduction to configuration management tools (e.g., Ansible, Puppet)	1	-	-
3.2	Managing system configurations and deployments	1	-	-
3.3	Configuration drift and remediation, Automating software deployments	1	-	-
3.4	Continuous Delivery and Deployment: Introduction to continuous delivery and deployment concepts	1	-	-

3.5	Release management and versioning, Automating deployment pipelines	1	-	-
	Total No. of Lecture Hours	15	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation" by Jez Humble and David Farley.
2. "DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations" by Gene Kim, Jez Humble, Patrick Debois, and John Willis.

Reference Book:

1. "Site Reliability Engineering: How Google Runs Production Systems" edited by Betsy Beyer, Chris Jones, Jennifer Petoff, and Niall Richard Murphy.
2. "Accelerate: The Science of Lean Software and DevOps: Building and Scaling High Performing Technology Organizations" by Nicole Forsgren, Jez Humble, and Gene Kim.

Online Resources:

1. NPTEL Course Link: https://nptel.ac.in/courses/128106012

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