



ESTD : 1946

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

ESTD : 1946

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 | | | | | | | | |

ESTD : 1946

| 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 | <ol style="list-style-type: none"> 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 | - | - |
| <i>Total No. of Lecture Hours</i> | | 40 | | |
| <i>Total No. of Tutorial Hours</i> | | 0 | | |
| <i>Total No. of Practical Hours</i> | | | | 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**Credits:4****SEE:50%Marks****SEE Hours: 3****Course Name: Computer Networks****L:T: P- 3:0:2****CIE:50%Marks****Max.Marks:100**

| | |
|-----------------------------|--|
| Prerequisites if any | Basic concepts of communication, Digital electronics and computers. |
| Learning objectives | <ol style="list-style-type: none"> 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 Tutorial Hours | No. of Practical Hours |
|--|--|----------------------|-----------------------|------------------------|
| Module-1: Introduction to Computer Networks and Network Layer | | | | |
| 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: Network Layer-Part I | | | | |
| 2.1 | IPv4 addresses: Address space, Classfull addressing | 1 | - | - |
| 2.2 | Classless addressing | 2 | - | - |
| 2.3 | DHCP, NAT | 1 | - | - |
| 2.4 | Forwarding of IP Packets: Forwarding Based on Destination Address | 1 | - | - |
| 2.5 | Network Layer Protocols: Internet Protocol, (IP): IPV4 Datagram format | 1 | - | - |
| 2.6 | Fragmentation Options, | 1 | - | - |
| 2.7 | Security of IPV4 datagram, ICMP Checksum | 1 | - | - |
| 2.8 | Next Generation IP: IPV6 Addressing | 1 | - | - |
| 2.9 | The IPV6 Protocol | 1 | - | - |
| Module-3: Network Layer-Part II | | | | |
| 3.1 | Unicast Routing: Routing Algorithms: Distance Vector Routing, | 1 | - | - |
| 3.2 | Linkstate Routing | 1 | - | - |
| 3.3 | Unicast Routing Protocols: Routing Information Protocol (RIP) | 1 | - | - |
| 3.4 | OSPF | 1 | - | - |
| 3.5 | Border Gateway Protocol (BGP): operation of External BGP (eBGP), Operation of Internal BGP (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, ICANN Ranges, Encapsulation and Decapsulation, Multiplexing and Demultiplexing, Flow control and Error Control | 1 | - | - |
| 4.2 | Connectionless and connection-oriented service, Transport Layer protocols: Introduction, services, port numbers | 1 | - | - |
| 4.3 | User Datagram Protocol: User Datagram and UDP services | 1 | - | - |
| 4.4 | Transmission Control Protocol: TCP services, TCP features, Segment | | | |
| 4.5 | TCP connection, Windows in TCP, Flow control (in brief) | | | |
| 4.6 | Error control: checksum, acknowledgement, generating acknowledgement, Retransmission - Retransmission after RTO, Retransmission after 3 duplicates, Out of order segments | | | |
| 4.7 | TCP congestion control: congestion window, congestion detection, Congestion policies, 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 of Experiments | | | | | |
|----------------------------|--|-------------------------------------|-----------|---|---|
| 1 | Study of networking devices like Hub, Repeater, Bridge, Switch, Router, Gateway, Access point, MODEM and NIC | | | | 1 |
| 2 | Write a program to implement the following Error Detection Techniques a. Cyclic Redundancy Check (CRC) b. Checksum | | | | 1 |
| 3 | a) Introduction to Cisco packet tracer. b) Create basic topologies and assign IP address, subnet mask, gateway IP address and test connectivity using PING command. | | | | 1 |
| 4 | Perform: a) An Initial Switch Configuration. (Host name, Console password, vty password, Privileged EXEC mode password, Privileged EXEC mode secret, IP address on VLAN1 interface, Default gateway) b) An Initial Router Configuration. (Configure the router host name, configure the passwords, configure the banner messages, verify the router configuration) | | | | 1 |
| 5 | Configure and implement DHCP service in a Local Area Network. also Configure Cisco Router as a DHCP sever. | | | | 1 |
| 6 | a. Implement the Static Routing and Default Routing. b. Configure WEP on a Wireless Router. | | | | 1 |
| 7 | Configure Dynamic Routing using RIP. | | | | 1 |
| 8 | Using TCP/IP sockets, write a client-server program to make the 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 | Defining and using Access Control Lists. | | | | 1 |
| | | Total No. of Lecture Hours | 40 | - | - |
| | | Total No. of Tutorial Hours | 00 | - | - |
| | | Total No. Of Practical Hours | 10 | | |

Textbook:

1. Behrouz Forouzan, "Data Communications and Networking", TataMcGraw-Hill, 5th Edition, 2013.

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, 4th Edition, 2002.
3. Data and Computer Communication, William Stallings, Pearson Education, 8th Edition, 2007

Online Resources:

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

Code: BCS503**Course: Automata Theory and Computation****Credits:4****L:T:P-3:2:0****SEE: 50 Marks****CIE:50 Marks****SEEHours:3****Max.Marks:100**

| | |
|-----------------------------|--|
| Prerequisites if any | Any Programming language, Discrete Mathematical structures |
| Learning objectives | <ol style="list-style-type: none"> 1. To give an overview of the theoretical foundations of computer science from the perspective of formal languages and illustrate finite state machines to solve problems in computing 2. To familiarize Regular grammars, context-free grammar and also to explain the hierarchy of problems arising in the computer sciences. |

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 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 |

Mapping with POs and PSOs:

| 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 |

Mapping Strength: 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 | Finite Automata with Epsilon Transitions | 1 | | |
| 1.5 | Elimination of Epsilon Transitions | 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 to Finiteautomata | 1 | 1 | |
| 2.5 | ApplicationsofRegularExpressions | 1 | | |
| Module–3:Properties ofRegularLanguages,ContextFreeGrammars | | | | |
| 3.1 | ProvingLanguagesnot to be regular, 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–Grammars to PDA | 2 | | |
| 4.3 | EliminationofEpsilon,UnitProductions,Uselessproductions | 2 | 1 | |
| 4.4 | ChomskyNormalForm | 2 | 1 | |
| Module–5:TuringMachines | | | | |
| 5.1 | IntroductiontoTuringMachines | 2 | | |
| 5.2 | Notation, Instantaneous description and transitions of Turning Machine | 2 | 1 | |
| 5.3 | Post'sCorrespondenceProblem | 2 | | |
| 5.4 | IntroductiontoClassPandNP problems | 2 | | |
| TotalNo.ofLecture Hours | | 40 | - | - |
| TotalNo. ofTutorial Hours | | 10 | - | |
| TotalNo. ofPractical Hours | | 00 | | |

Textbook:

1. John E Hopcroft, Rajeev Motwani, Jeffrey D Ullman, *Introduction to Automata Theory, Languages, and Computation*, 3rd Edition, Pearson Education

Reference Book:

1. Sipser, Michael. *Introduction to the Theory of Computation*. 3rd ed. Cengage Learning, 2012. ISBN: 9781133187790.
2. Peter Linz, *An Introduction to Formal Languages and Automata*

| 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.

Mapping with POs and PSOs:

| 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.N o | CO's | Experiments |
|-----------|-----------------|--|
| 1 | CO1 | <p>Introduction to Python for Machine Learning</p> <p>Objective: Install necessary libraries and set up the environment for machine learning in Python.</p> <p>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.</p> |
| 2 | CO1 & CO2 | <p>End-to-End Machine Learning Project</p> <p>Objective: Work through a complete machine learning project.</p> <p>Tasks: Use a real-world dataset, perform data cleaning, feature engineering, model training, and evaluation.</p> |

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

| | | |
|----|-----|---|
| 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**Credits: 3****SEE: 50 Marks****SEE Hours: 3****Course: MACHINE LEARNING****L:T:P - 3:0:0****CIE: 50 Marks****Max. Marks:100**

| | |
|-----------------------------|---|
| Prerequisites if any | None |
| Learning objectives | <ol style="list-style-type: none"> 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 | PO1 0 | PO1 1 | PO1 2 | 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 | | |
| | <i>Total No. of Lecture Hours</i> | 40 | - | - |
| | <i>Total No. of Tutorial Hours</i> | 00 | - | |
| | <i>Total No. of Practical Hours</i> | 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: BCI516B**Credits: 3****SEE: 50 Marks****SEE Hours: 3****Course: Information Retrieval****L:T:P - 3:0:0****CIE: 50 Marks****Max. Marks: 100**

| | |
|-----------------------------|---|
| Prerequisites if any | Databases, Probability and Statistics. |
| Learning objectives | <ul style="list-style-type: none"> 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 retrieval systems, including models, data processing, retrieval challenges, and search architectures. | Understand |
| CO2 | Apply information retrieval models and pre-processing to manage and retrieve structured and multimedia data using enterprise and web search systems.. | Apply |
| CO3 | Analyze information retrieval models, pre-processing methods, retrieval challenges, and search system architectures and ranking techniques. | Analyze |
| CO4 | Evaluate information retrieval models, pre-processing methods, retrieval effectiveness, and search system architectures. | 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: BC1516C**Credits: 3****SEE: 50 Marks****SEE Hours: 3****Course: Nonlinear Control Systems****L:T:P - 3:0:0****CIE: 50 Marks****Max. Marks: 100**

| | |
|-----------------------------|--|
| Prerequisites if any | Mathematics, Basic Control Theory, Signals and Systems |
| Learning objectives | <ul style="list-style-type: none"> 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 | - | - |
| <i>Total No. of Lecture Hours</i> | | 40 | - | - |
| <i>Total No. of Tutorial Hours</i> | | 00 | - | |
| <i>Total No. of Practical Hours</i> | | 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 | <ul style="list-style-type: none"> 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 | - | - |
| | <i>Total No. of Lecture Hours</i> | 40 | - | - |
| | <i>Total No. of Tutorial Hours</i> | 00 | - | |
| | <i>Total No. of Practical Hours</i> | 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 MATLAB”, 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 \(nptel.ac.in\)](https://nptel.ac.in/courses/107106013/)

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 | <ul style="list-style-type: none"> 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 | | P S O 1 2 | P S O 1 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 | Device 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, Addison 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 | <p>Clearly state the goals and objectives of the project.</p> <p>Determine the scope and expected outcomes.</p> <p>Collaborate with classmates for the project teamwork.</p> <p>Assign roles and responsibilities based on each team members strengths.</p> <p>Identify potential risks and challenges that might arise during the project.</p> <p>Maintain detailed records of your project , design, and development process.</p> <p>Prepare to present your findings and results clearly and comprehensively.</p> |

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 | <ol style="list-style-type: none"> 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 | | | | Cr ed its | | | | | | | | | | |
|--------------|----------------|-------------|---|--------------------------|------------------------------------|-------------------------------|---|---|---|----------------------|-------------|-------------|---------------|-----------|--|--|--|--|--|--|--|--|--|--|
| | | | | | | L | T | P | S | Dur atio n in Ho urs | CI E Ma rks | SE E Ma rks | Tot al Ma rks | | | | | | | | | | | |
| 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/SD C | BCI657X | Ability Enhancement Course / Skill Development Course V | CS | CS | If the course is a Theory | | | | 50 | 50 | 100 | 1 | | | | | | | | | | | |
| | | | | | | 1 | 0 | 0 | | | | | | | | | | | | | | | | |
| | | | | | | OR | | | | | | | | | | | | | | | | | | |
| | | | | | | If the course is a Laboratory | | | | | | | | | | | | | | | | | | |
| | | | | | | 0 | 0 | 2 | | | | | | | | | | | | | | | | |
| 9 | MC | BNSK658 | National Service Scheme (NSS) | NSS Coordinator | | 0 | 0 | 2 | | - | 100 | - | 100 | 0 | | | | | | | | | | |
| | | BPEK658 | Physical Education (PE) (Sports & Athletics) | PED | | | | | | | | | | | | | | | | | | | | |
| 10 | MC | BYOK658 | Yoga | Yoga Teacher | | 1 | 0 | 0 | 0 | 0 | 50 | - | 50 | 0 | | | | | | | | | | |
| | | BMUK658 | Music | Music Teacher | | | | | | | | | | | | | | | | | | | | |
| | | BIKK259 | Indian Knowledge Systems | Humanities | | | | | | | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 500 | 400 | 900 | 22 | | | | | | | | | | |

ESTD : 1946

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 | - | - |
| <i>Total No. of Lecture Hours</i> | | 40 | | |
| <i>Total No. of Tutorial Hours</i> | | | 0 | |
| <i>Total No. of Self learning Hours</i> | | | 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 | <ul style="list-style-type: none"> 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, Recurrent Neural Networks, Bidirectional RNNs, | 3 | | |
| 4.2 | Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks | 2 | | |
| 4.3 | Echo State Networks, The Long Short-Term Memory and 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, Denoising Autoencoders | 3 | | |
| 5.3 | Contractive Autoencoders, Applications of Autoencoders | 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 | <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> 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 | - | - |
| <i>Total No. of Lecture Hours</i> | | 40 | - | - |
| <i>Total No. of Tutorial Hours</i> | | 00 | - | |
| <i>Total No. of Practical Hours</i> | | 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 | <ul style="list-style-type: none"> 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 | | |

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|------------------|---|---|--|--|
| 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 | | |
| <i>Total No. of Lecture Hours</i> | | 40 | - | - |
| <i>Total No. of Tutorial Hours</i> | | 00 | - | |
| <i>Total No. of Practical Hours</i> | | 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, Debjani 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. <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 | <ul style="list-style-type: none"> 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 | - | - |

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|-----|--|-----------|---|---|
| 5.4 | Case studies | 2 | - | - |
| | <i>Total No. of Lecture Hours</i> | 40 | - | - |
| | <i>Total No. of Tutorial Hours</i> | 00 | - | |
| | <i>Total No. of Practical Hours</i> | 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 | | |

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|--|---|-----------|---|---|
| 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 | | |
| <i>Total No. of Lecture Hours</i> | | 40 | - | - |
| <i>Total No. of Tutorial Hours</i> | | 00 | - | |
| <i>Total No. of Practical Hours</i> | | 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>
- 2. <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 machine learning 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 | Bootstrap 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 | | | |
| | | <i>Total No. of Lecture Hours</i> | 40 | - | - |
| | | <i>Total No. of Tutorial Hours</i> | 00 | - | |
| | | <i>Total No. of Practical Hours</i> | 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 | <ul style="list-style-type: none"> • 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. Reema Thareja, —Data Structures using C, 2nd Edition, 2018, Oxford University Press.

Reference Book:

1. Aaron M Tenenbaum, Yedidyah Langsam and Moshe J Augenstein, —Data Structures using C, 2014, low price edition, Pearson education,.
2. Richard F Gilberg and Behrooz A 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**Credits: 3****SEE: 50 Marks****SEE Hours: 3****Course: Fundamentals of Operating Systems****L:T:P - 3:0:0****CIE: 50 Marks****Max. Marks: 100**

| | |
|-----------------------------|--|
| Prerequisites if any | C Programming, Data Structures, Object Oriented Programming, Computer Organization |
| Learning objectives | <ul style="list-style-type: none"> • 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=PLG9aCp4uEs17rFjWM8KchGlffXgOzzVP>
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 | <ul style="list-style-type: none"> • 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 data with 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: BCI654D**Credits: 3****SEE: 50 Marks****SEE Hours: 3****Course: Introduction to AI****L:T:P: 3:0: 0****CIE: 50 Marks****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 | Iterative 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 | | | |
| <i>Total No. of Lecture Hours</i> | | 40 | | | |
| <i>Total No. of Tutorial Hours</i> | | 00 | | | |
| <i>Total No. of Practical Hours</i> | | 00 | | | |

Textbook:

1. Artificial Intelligence, Saroj Kaushik Cengage Learning 2014 Edition

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 | <ol style="list-style-type: none"> 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 | | | |
| | | <i>Total No. of Lecture Hours</i> | 50 | - | - |
| | | <i>Total No. of Tutorial Hours</i> | 00 | - | |
| | | <i>Total No. of Practical Hours</i> | 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**Credits: 3****SEE: 50 Marks****SEE Hours: 3****Course: Data Mining****L:T:P - 3:0:0****CIE: 50 Marks****Max. Marks: 100**

| | |
|-----------------------------|--|
| Prerequisites if any | Databases, Statistics and Probability. |
| Learning objectives | <ul style="list-style-type: none"> 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 of data – 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 | | |
| CO2 | 3 | 2 | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | | |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | | |
| CO4 | 3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | | |

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

| Sl No | CO's | Experiments |
|-------|-----------|---|
| 1 | CO1 | <p>Basic Neural Networks</p> <p>Objective: Implement basic neural network components.</p> <p>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.</p> |
| 2 | CO1 & CO2 | <p>Deep Feedforward Networks</p> <p>Objective: Implement a multilayer perceptron (MLP) and train it using the back-propagation algorithm.</p> <p>Tasks: Train an MLP on the XOR problem, and demonstrate gradient-based learning and the use of hidden units.</p> |

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

Textbook

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

2. Deep Learning by Ian Goodfellow, Yoshua Bengio, 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 | <ul style="list-style-type: none"> • 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 interpretable 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-box <https://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**Credits: 1****SEE: NA****SEE Hours: NA****Course: PyTorch****L:T:P-1:0:0****CIE:50 Marks****Max. Marks:50**

| | |
|-----------------------------|---|
| Prerequisites if any | Basics of Python |
| Learning objectives | <ul style="list-style-type: none"> 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 learning and 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 | - | - |
| | | <i>Total No. of Lecture Hours</i> | 15 | - |
| | | <i>Total No. of Tutorial Hours</i> | 00 | - |
| | | <i>Total No. of Practical Hours</i> | 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 | <ul style="list-style-type: none"> 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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ESTD : 1946