Autonomous Program Structure
Final Year B. Tech. Eighth Semester Computer Engineering
Academic Year: 2023-2024 Onwards

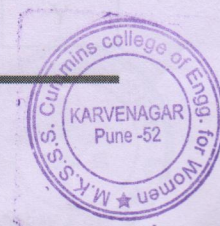| Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Marks	Credit
		Lecture	Tutorial	Practical	In Semester	End Semester	Oral	Practical		
20CE801	Information Security	3	0	0	50	50	0	0	100	3
20PECE801	Program Elective-IV	3	0	0	50	50	0	0	100	3
20PECE802	Program Elective-V	3	0	0	50	50	0	0	100	3
20OE801	Open Elective-III	3	0	0	50	50	0	0	100	3
20OE802	Open Elective-IV*	3	0	0	50	50	0	0	100	3
20CE801L	Information Security Laboratory	0	0	4	25	0	25	0	50	2
20PECE801L	Program Elective–IV Laboratory	0	0	2	25	0	25	0	50	1
	Total	**15**	**0**	**6**	**300**	**250**	**50**	**0**	**600**	**18**
	Grand Total	**21**			**600**					**18**

Programme Elective-IV	Programme Elective-IV Laboratory
20PECE801A Introduction to Natural Language Processing	20PECE801LA Introduction to Natural Language Processing
20PECE801B User Experience Design (UX/UI)	20PECE801LB User Experience Design (UX/UI)
20PECE801C Multimedia Systems	20PECE801LC Multimedia Systems
20PECE801D Artificial Intelligence	20PECE801LD Artificial Intelligence
20PECE801E Internet of Things	20PECE801LE Internet of Things

Programme Elective-IV	Programme Elective-IV Laboratory
20PECE801A Introduction to Natural Language Processing 20PECE801B User Experience Design (UX/UI) 20PECE801C Multimedia Systems 20PECE801D Artificial Intelligence 20PECE801E Internet of Things	20PECE801LA Introduction to Natural Language Processing 20PECE801LB User Experience Design (UX/UI) 20PECE801LC Multimedia Systems 20PECE801LD Artificial Intelligence 20PECE801LE Internet of Things

Programme Elective-V
20PECE802A Operation Research **20PECE802B** Distributed Systems **20PECE802C** Information Retrieval **20PECE802D** Parallel Computing **20PECE802E** Introduction to Blockchain

20OE801 Open Elective-III

Sr. No.	Course Code	Course Title	Eligible Departments				
			EnTC	Comp	IT	Mech	Instru
1	20OE801A	Big Data and Analytics	Y	Y	Y	Y	Y
2	20OE801B	Cyber Physical Systems	Y	Y	Y	N	Y
3	20OE801C	Digital Control	Y	N	N	Y	Y
4	20OE801D	Industrial Engineering and Management	Y	Y	Y	Y	Y
5	20OE801E	Introduction to Cyber-crime and Forensics	Y	Y	Y	Y	Y
6	20OE801F	Instrumentation in Food and Agriculture	Y	Y	Y		

Department of Computer Engineering
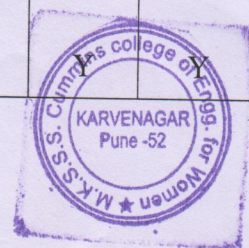
7	20OE801G	Medical IoT	Y	Y	Y	N	Y
8	20OE801H	Quantum Computing	Y	Y	Y	N	Y
9	20OE801I	Renewable Energy Sources	Y	Y	Y	Y	Y
10	20OE801J	Soft Computing	Y	Y	Y	Y	Y
11	20OE801K	Software Testing and Quality Assurance	Y	Y	Y	Y	Y

20OE802 Open Elective-IV
* Multi-disciplinary Course

Sr. No.	Course Code	Course Title	Eligible Departments				
			EnTC	Comp	IT	Mech	Instru
1	20OE802A	Applied statistics with R Programming	Y	N	N	Y	Y
2	20OE802B	Automobile Engineering	Y	Y	Y	N	Y
3	20OE802C	Autonomous Robots	N	Y	Y	Y	N
4	20OE802D	Building Automation and Energy Audit	Y	Y	Y	Y	N
5	20OE802E	Data Analysis and Visualization	Y	N	Y	Y	Y
6	20OE802F	Data Science using Python	Y	N	Y	Y	Y
7	20OE802G	Industrial Drives and Control	Y	Y	Y	Y	N
8	20OE802H	Smart Sensors and Structures	Y	Y	Y	Y	N
9	20OE802I	Wireless Networks	N	Y	Y	N	Y

Department of Computer Engineering

20CE 801 Information Security

Teaching Scheme	**Examination Scheme**
Lecture: 3 Hours. /week	In Semester: 50 Marks
	End Semester: 50 Marks
	Credits: 3

Prerequisite(s): Computer Networks (20CE 501)

Course Objectives:
To facilitate the learners to-
1. Understand the fundamental concepts of security.
2. Know the basics of cryptography
3. Identify the role of security protocols at various layers.
4. Understand network security threats, security services and countermeasures.

Course Outcomes:
By taking this course, the learner will be able to–
1. Make use of principles of Cryptosystem for Data Protection
2. Identify various techniques to provide Data security and Integrity over the network
3. Choose appropriate security mechanisms to mitigate various security challenges
4. Identify security mechanisms for Network Perimeter and specific Applications

Unit 1: Introduction to Security (06)
Need and significance of Security, Architectures, Introduction to common attacks (e. DOS, Phishing, SQL injection, Cross site scripting etc), Active Vs Passive Attacks, A model for Network and Internetwork Security, TCP/IP security Architecture (services and Mechanism),Introduction to cryptography- Classical Cryptography.

Unit 2: Introduction to Cryptography (07)
Introduction to secrete key cryptography, Cipher Basics, Introduction to DES, DES Analysis, DES variants, Introduction to AES and IDEA, Block cipher modes
of operations.

Unit 3: Public Key Cryptography and Key Management (08)
Introduction to Public Key cryptography, The RSA algorithm, Analysis of RSA, Key Management Basics, Diffie- Hellman Key exchange, Key distribution of Private and Public Keys.

Unit 4: Message Integrity and Authentication (08)
Need and Significance of Message Digest, One way hash functions and properties of hash functions, MD5, SHA, Message authentication, Introduction and overview of Digital Signatures: Implementation, Algorithms standards(DSS),Digital Certificates and X.509, Certificate structure, Certificate revocation.

Unit 5: Network Security (07)
Introduction to Network Layer Security- Overview of Firewall, Design principles of Firewalls, Various types of firewalls and their working principles, Concept of VPN,Tunnelling protocols, working of IPSEC. Introduction to transport Layer security – SSL/ TLS protocol.

Unit6: Application Security and Authentication Mechanisms (06)
Overview of Application Security, Overview of Wireless Security. User Authentication Mechanisms, Kerberos v4 and v5.Overview of Cloud security, Overview of IOT security,

Text Books:
1. William Stalling **'Cryptography and Network Security, principles and practices'**, 7th *Edition. Pearson* ISBN 978-93-325-8522-5

2 William Stalling, Lawrie Brown **'Computer Security: Principles and Practice,** 4th Edition, Pearson ISBN 978-9353438869

Reference Books:
1. Atul Kahate, **'Cryptography and Network Security'**, 4*rd edition McGraw Hill Publication.2019* ISBN 9789353163310

2. Bernard Menezes, **'Network Security and Cryptography'**, *Cengage Learning.* ISBN 978-8131513491

3. *Bruce Schneier:* **'Applied Cryptography –Protocols, Algorithm and Source Code in C'**, *Second Edition, John Wiley & Sons, New York,* ISBN 978-1-119-09672-6.

4. Charlie Kaufman, Radia Perlman and Mike Speciner, **'Network security, private Communication In a Public World'** ISBN978-0130460196

20CE 801L Information Security Laboratory

Teaching Scheme
Practical: 4 Hours/week

Examination Scheme
In Semester : 25 Marks
Oral : 25 Marks
Credits: 2

Course Objectives:

To Facilitate the Learners to:-

1. Understand Basic CryptographyAlgorithms
2. Learn various techniques for secure data transmission
3. Recognize the need of Network Perimeter Security
4. 4. Learn various techniques used for common attacks

Course Outcomes:

By taking this course the learner will be able to:-

1. Implement Standard CryptographyAlgorithms
2. Apply the digital signature for authentication
3. Apply packet filtering concept to configure Firewall
4. Demonstrate common attacks

Sample /Suggested List of Assignments:

1. Implement DES algorithm

2. Implement RSAalgorithms

3. Implement Message Digest Algorithm and demonstrate the collision resistance property

4. Implementation of Diffie Hellman Key exchange for sharing the secret key.

5. 2 users are doing business online. Develop and demonstrate suitable solutions which will take care of user authentication along with Non repudiation.

6. Simulation of packet Filtering concepts.

7. Create a small application to demonstrate attacks (e.g SQL injection ,Cross Site scripting)

8. Develop and demonstrate how the contents of the web site will be made secure against the common attacks.

9. Case Study - Enterprise network Security/ Wireless Security / Security Information and Event Management

20PECE 801A Introduction to Natural Language Processing

Teaching Scheme

Lectures: 3 Hours / Week

Examination Scheme

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 3

Course Objectives:

To facilitate the learner to

1. Understand various aspects of Natural Language Processing.

2. Learn Phonological, Morphological, Syntactic and Semantic processing

3. Understand issues related to ambiguity of Natural Language.

4. Understand the advanced applications of Natural Language Processing.

Course Outcomes:

After completion of the course, students will be able to

1 Identify importance of Natural Language Processing.

2 Apply the fundamental concepts and techniques of Natural Language.

3 Identify ambiguous structure of Language.

4 Analyze the advanced applications of Natural Language Processing.

Unit I: Introduction to Natural Language Processing   (6)

The Study of Language, Applications of Natural Language Understanding, Evaluating language Understanding Systems, Different levels of Language Analysis.

Unit II: Fundamentals of Phonics   (7)

Speech Sounds and Phonetic Transcription, Articulatory Phonetics, The Vocal Organs, Place of Articulation of Consonants, Manner of Articulation of Consonants, Vowels, Syllables, Phonological Categories and Pronunciation Variation, Phonetic Features, Predicting Phonetic Variation, Factors Influencing Phonetic Variation.

Unit III: Fundamentals of Morphology   (7)

Concept of Morphology, Survey of English Morphology, Inflectional Morphology, Derivational Morphology, Cliticization, Non-Concatenative Morphology, Agreement, Finite-State Morphological Parsing, Construction of Finite-State Lexicon, Finite-State Transducers(FST), Sequential Transducers and Determinism, Finite-State Transducers for Morphological Parsing, Transducers and Orthographic Rules, Word and Sentence Tokenization.

Unit IV: Semantic Analysis   (8)

Part-of-Speech Tagging, POS-Tagging Perspective, POS tagging and HMM, POS-Tag Set, Parsing Algorithms,Parsing in case of Ambiguity; Probabilistic Parsing .Parser Comparison, Grammar; Constituency, Dependency , Inside Probability; Parse Tree construction,language modelling

Unit V: Discourse and Pragmatics   (7)

Discourse Structure and Reference, Relating Discourse Structure and Inference, Discourse Structure, Tense, and Aspect, Managing the Attentional Stack, Concept of Pragmatics

Unit VI: Applications of Natural Language Processing   (7)

  Machine Translation, Sentiment Analysis, Question Answering Systems, Cross Lingual Information Retrieval,Natural Language Interface to Database, Extractive and Abstractive Summarization Systems, Indian Language WordNets.

Text Books:

1.   Jurafsky, David, James H. Martin, 'Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition', Pearson Education Limited, Dorling Kindersley(India) Pvt. Ltd. (Indian Subcontinent Version)(2014), ISBN: 987-93-325-1814-4.

2.   James Allen, 'Natural Language Understanding', Pearson Education Limited, Dorling Kindersley(India) Pvt. Ltd. (Indian Subcontinent Version)(2007), ISBN: 987-81-317.

Reference Books:

1.   Manning, Christopher D., Hinrich Schütze, 'Foundations of Statistical Natural Language Processing', Cambridge Publication(1999), ISBN: 0262133601. 2. Steven Bird, ewan Klein, and Edward Loper, 'Natural Language Processing with Python', O'Reilly Media, 2009.

2.   Flanagan, J. L. Speech Analysis, Synthesis and Perception. 2nd ed. New York, NY: Springer-Verlag,. ISBN: 9780387055619.

Online/Web/Other References:

1. NPTEL NLP course: https://nptel.ac.in/courses/106/105/106105158/

20PECE 801B User Experience Design (UX/UI)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hours / Week	In Semester: 50 Marks
	End Semester: 50 Marks
	Credits: 3

Course Objectives:

To facilitate the learner to

1. Understand the basic concepts of UI/UX Design in order to design with intention.

2. Achieve a deep understanding of the entire life-cycle of design process.

3. Provide a visual understanding of product to make user interaction as easy and efficient as possible.

4. Understand various design technologies for mobile and web to help avoid common mistakes and meet user requirements

5. Understand the advanced techniques of User Experience Design

Course Outcomes:

After completion of the course, students will be able to

1. Apply the concepts areas of study in UX to enhance the user experience

2. Apply the key psychological principles that underlie UX design principles

3. Construct the wireframes and prototypes for interactive products to establish the structure and flow of possible design solutions.

4. Apply the fundamental aspects of designing and evaluating the interfaces for mobile and web.

5. Compare the advanced techniques of User experienec Design

Unit I: **Introduction to User Experience** (6)

What is User Experience, Relationship Between UI and UX, Why is UX Design so Important, What is UX Design and Where is Used, Usability: A part of the User Experience, Understanding User Experience, Psychology of everyday actions, Concept of UX, Trends in UX, What is User Interaction, Mental Model, Cognitive Model in UX, Emerging Technologies in UX, Universal Design, User-centered design, Human Centered Design.

Unit II: **Design Thinking** (8)

Key elements of Design thinking, Design Thinking Skills-What are wicked problems and its solution, Good and poor design, Empathy Users- User research, Personas, Define problem, , Ideation- Identifying Customer Needs, Translate user needs into product specifications, Applied Creativity, Brainstorming, Prototyping, From Prototype to Product Development, Testing Design Solutions, Relation of Design thinking with UX, Design thinking applications, Applying design thinking to mobile and wed.

Unit II: **Interaction Styles** **(6)**

Design principles and rules, Shneiderman's golden rules, Normans seven principles, Nielsens ten heuristics with example of its use,Heauricstic evaluation. Direct Manipulation – Windows Characteristics, Components, Presentation styles, Icons, Multimedia and colors, Menu selection, Form Fill-in and Dialog Boxes, Icons, Fitts'law and Hick-Hyman's law.

Unit IV: **UX Design Process** **(7)**

Elements of User Experience Design, Stages of UX design,
Visual Design - Vision and Memory,Visual Design Principles, Data Visualization, Wire framing & Storyboarding, Converting the wireframes into visual design, Prototyping, Various Prototyping Tools, Elements and Widgets. Gestalt Principles and Grids, Layout Expectations, Forms and Data Entry
Screen Design and Layout- Screen planning and purpose, organizing screen elements, ordering of screen data and content , screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully
UX Design Tools

Unit V: **UX Design for Mobile and Web** **(8)**

Mobile Usability Research – The Important Differences from the Desktop. Smartphone vs. Tablet, UI mobile components and patterns, Application frameworks: Types of Mobile Applications: Widgets, Applications, Mobile Design: Elements of Mobile Design
Web user Interface - The Gestalt Principles of Perceptual Organization, The Law of Similarity, Proximity, Familiarity/Meaningfulness, Symmetry, Continuity, The Principle of Closure, 'New' Grouping Laws, The Law of Element Connectedness, The Law of Common Region.
Types of Evaluation research, Usability Testing.

Unit VI: **Interaction Technologies** **(7)**

Explicit and Implicit Human Computer Interaction – Gesture interfaces, Speech Recognition, Tangible interfaces, Auditory Interfaces, Natural Language Interfaces, User Interfaces and Interaction for Four Widely Used Devices.
Hidden User Interface via Basic smart Devices, Hidden User Interface via Wearable and Implanted Devices, Virtual and Augmented Reality.

Text Books:

1. Interaction Design: Beyond Human-Computer Interaction: Book by Helen Sharp Jenny Preece, and Yvonne Rogers

2. Wilbert O. Galitz'Wiley The Essential Guide to User Interface Design' 3rd Edition Apr 2007

Reference Books:

1. Don Norman, 'The Design of Everyday Things', Basic Books, A member of the Perseus Books Group, (2013)

2. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, 'Designing the User Interface: Strategies for Effective Human-Computer Interaction', Pearson Education Limited (India),(2010)

Online/Web/Other References:

1. https://www.interaction-design.org/courses/user-experience-the-beginner-s-guide

2. https://www.coursera.org/learn/user-experience-design#syllabus

20PECE 801C Multimedia Systems

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hours / Week	In Semester: 50 Marks
	End Semester: 50 Marks
	Credits: 3

Course Objectives:
To facilitate the learner to
1. Understand the Basics of Multimedia Systems.
2. Understand various file formats.
3. Learn Multimedia editing tools.
4. Analyse various compression techniques.
5. Learn advances in Multimedia.

Course Outcomes:
1. After completion of the course, students will be able to

2. Build the knowledge of multimedia systems and its characteristics.
3. Utilize text and audio file formats and compression techniques in multimedia Applications.
4. Apply digital image and video processing techniques used in multimedia Applications.
5. Build the knowledge of animation and virtual reality concepts.
6. Build the knowledge of advances in multimedia.

Unit I: Introduction to Multimedia   **(06)**

What is multimedia (Text, Graphics, Audio, Video, Animation),

Multimedia presentation and production, Hardware and software requirements of multimedia, Multimedia Applications.

Unit II: Text and Audio   **(08)**

Text - Introduction, About Fonts and Faces, Using Text in Multimedia. Font editing and design tools. Text Compression (HUFFMAN, LZ, LZW), File Formats (TXT, DOC, RTF, PDF, PS), Hypertext and Hypermedia. Audio – Introduction, Characteristics of Sound, Elements of Sound system, Digital Audio, Synthesizer, MIDI, Audio File formats, (WAV, VOC, MP3) Audio Processing Software.

Unit III: Understanding and Processing Images   **(07)**

Digital Image Representation, Types of Images (monochrome, gray, color), File formats (BMP, TIFF), Image Compression Techniques Fundamentals,

Types-lossless and lossy Compression. Lossless Compression Algorithms-Shannon-Fano
Lossy Compression Algorithm-JPEG

Unit IV: **Handling Video Data** (07)

Types of video signals, Analog video, Digital video, Video File formats and CODEC (AVI and MPEG), Case study Video Editing Software / Tools.

Unit V: **Animation and Virtual Reality** (07)

Animation – Introduction, Uses, Types, Principles, Animation on Web, 3D animation, Rendering, Animation Software requirements, Devices, VRML

Unit VI: **Introduction to Advances in Multimedia** (07)

Introduction, Challenges of Multimedia Information processing Watermarking, Organization, Storage and Retrieval issues, Neural networks for Multimedia processing, Multimedia processors. Introduction to Augmented Reality.

Text Books:

1. Ranjan Parekh, "Principles of Multimedia",TMH, ISBN 0-07-058833-3(2nd Edition,2007)
2. Ralf Steinmetz and Klara Nahrstedt "Multimedia Computing, Communication and Applications", Pearson Education.(8 th impression 2011)

3. Nigel Chapman and Jenny Chapman. Wiley "Digital Multimedia" (2nd Edition).

Reference Books:
1. Ze-Nian Li, Marks S. Drew, "Fundamentals of Multimedia", Pearson Education.
2. Tay Vaughan , '*Multimedia: Making it work'*, *Tata McGraw-Hill, (*8th edition)*, (2011)
3. Judith Jeffcoate, 'Multimedia in Practice'*, Prentice Hall of India,* (2003)
4. Gonzalez, Woods, "Digital Image Processing" Addison Wesley
5. Mark Nelson "Data Compression Book ", BPB
6. Judith Jeffcoate "Multimedia in Practice":, PHI.

20PECE 801D Artificial Intelligence

Teaching Scheme

Lectures: 3 Hours / Week

Examination Scheme

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 3

Course Objectives:

To facilitate the learner to

1. Learn overview and basics of classic Artificial Intelligence.
2. Understand various intelligent searches and knowledge representation.
3. Understand types of learning used in artificial intelligence.
4. Study applications in Artificial Intelligence.

Course Outcomes:

After completion of the course, students will be able to

1. Build fundamental knowledge of AI, its applications and solve classical AI problems using different AI Techniques
2. Apply intelligent search algorithms on AI problems.
3. Make use of Knowledge Management techniques of AI for reasoning.
4. Make use of various learning techniques to solve the given problem.
5. Examine different topics with various methods of expert system, pattern recognition, natural language processing, nature inspired computing.

Unit I: Introduction to AI **(6)**

Definitions of Artificial Intelligence, History of Artificial Intelligence, Artificial Intelligence Problems, Present state of AI, Intelligent agents, Topics of Artificial Intelligence: Learning Systems, Knowledge Representation and Reasoning, Planning, Knowledge Acquisition, Intelligent Search, Logic Programming, Soft Computing, Management of Imprecision and Uncertainty, Branches and applications of Artificial Intelligence.

Unit II: Uninformed search and modelling a search problem **(7)**

Generate-and-Test, Search Techniques: Depth First Search, Breadth First Search, Production Systems: Traveling Salesman Problem, Water-Jug Problem, State Space Representation, State Space Search, Tic-Tac-Toe as a State Space.

Unit III: Heuristic Search Techniques (8)

Best First Search Algorithm, Hill Climbing, Simulated Annealing, A* Algorithm, Problem Reduction, AND–OR Graphs, The AO* Algorithm, Towers of Hanoi Problem, Constraints Satisfaction: crypt-arithmetic problem, mini-max algorithm.

Unit IV: Knowledge Management (7)

Knowledge Management, Types of Knowledge: Declarative Knowledge, Procedural Knowledge, Knowledge Representation, Approaches to Knowledge Representation, Issues in Knowledge Representation, First-order Logic: Basic Predicate Representations, Conversion of WFF to Clause Form, Resolution, Unification, Resolution Examples, Reasoning, monotonic and non-monotonic reasoning.

Unit V: Learning (7)

Types of Learning: Rote Learning, Learning by General Problem Solving, Concept Learning, Learning by Analogy, learning problems and designing the learning systems, Reinforcement learning.

Unit VI: Applications in Artificial Intelligence (7)

Game Playing, Expert Systems, Natural Language Processing, Pattern Recognition, Recommendation system, Nature Inspired Computing.

Text Books:

1. Vinod Chandra S. S., Anand Harendra S., 'Artificial Intelligence and machine learning', PHI, (2014), ISBN 978-81-203-4934-6.

2. Kulkarni P., Joshi P., 'Artificial Intelligence: Building Intelligent Systems', PHI Learning, (2015), ISBN 978-81-203-5046-5.

Reference Books:

1. Peter, Norvig, 'Artificial Intelligence: A Modern Approach', Pearson, (3rd edition), (2014), ISBN-0-13-103805-2.

2. Elaine Rich, Kevin Knight and Nair, 'Artificial Intelligence', Tata McGraw – Hill, (3rd edition), (2012), ISBN-978-0-07-008770-5.

3. Bratko I., 'Prolog Programming for Artificial Intelligence', Pearson Education, (3rd edition), (2004).

4. Tom M. Michell, 'Machine Learning', McGraw Hill Education, Indian edition (2013), ISBN-13: 978-1-25-909695-2.

5. Ethem Alpaydin, 'Introduction to Machine Learning', PHI, (2006), ISBN-81-203-2791-8.

Online/Web/Other References:

1. https://nptel.ac.in/courses/106/105/106105077/

2. https://nptel.ac.in/courses/106/106/106106126/

3. https://onlinecourses.nptel.ac.in/noc19_me71/preview

4. https://onlinecourses.nptel.ac.in/noc20_cs42/preview

20PECE 801E Internet Of Things

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hours / Week	In Semester: 50 Marks
	End Semester: 50 Marks
	Credits: 3

Course Objectives:

To facilitate the learner to

1. To understand the fundamental concepts, basic design and components in Internet of things(IoT).

2. Understand and design smaller systems for various devices.

3. To understand the various protocols used in IoT.

4. Learn and implement smaller scenarios using programming language.

5. To understand fundamentals of security in IoT and web and cloud based services for IoT.

Course Outcomes:

After completion of the course, students will be able to

1. Understand and recall the Internet of Things with different components and design process.

2. Apply the various things and design a system.

3. Analyse through Knowledge gain and skills to select application layer protocols for seamless integration of various components of an IoT ecosystem.

4. Implement smaller codes with python programming.

5. Recall the fundamentals of security used in IoT with the different services provided in web and cloud.

Unit I: Introduction to Internet of Things   (7)

IoT: Definition and characteristics of IoT, Vision of IoT, IoT Ecosystem, IoT Reference Model, Physical Design Model, Logical Design: Functional Block, Communication models, Communication API's, IoT enabling Technologies, IoT Levels and Deployment Templates, Applications of IoT, IoT & M2M.

Unit II: Embedded Devices and Programming for IoT   (7)

Transducers, Sensors and Actuators for IoT, Introduction to Arduino, Beagle Bone Black, Raspberry Pi, Python Programming for IoT devices.

Unit III: IoT Protocols   (7)

Protocol Classification, Protocols for different Layers: Link layer, network layer, Transport layer and Application Layer: Message Queue Telemetry Transport (MQTT), Extensible Messaging and Presence Protocol (XMPP), Data Distribution Services (DDS), Advanced Message Queuing Protocol (AMQP), Constrained Application Protocol (COAP), Representational State Transfer (REST), Comparison of Protocols.

Unit IV: IoT Platform Design methodology and Case studies   (7)
                 for IoT Design

Introduction to IoT platform Design methodology, Steps involved in IoT system Design methodology, Case studies: Home automation, Smart cities, Agriculture.

Unit V: Web of things and Cloud of Things   (7)

Four pillars of IoT paradigms, Two Pillars of Web, Cloud of things architecture, Four Deployment Models: Private, Public, Community and Hybrid, Cloud computing paradigm: data collection, Storage and Computing, Gateways used in IoT for Data communication on Cloud, IoT cloud-based Services using Xivel, Nimbits and other platforms, Applications and features of Cloud IoT.

Unit VI: IoT Privacy, Security and Vulnerabilities Solutions   (7)

Introduction to security, Vulnerabilities, Security requirements and Threat Analysis, Use and Miuses Cases, IoT Security Tomography and Layered Attacker Model, Identity Management and Establishment, Access control and Secure Message communication, Security Models, Profiles and Protocols for IoT.

Text Books:

1. Arshdeep Bagha, Vijay Madisetti, 'Internet of Things – A Hands-on-approach', Universities Press (2014).

2. Srinivasa K.G., Siddesh G.M., Hanumantha Raju R., 'Internet of Things',Cengage Publication

3. Rajkamal, 'Internet Of Things: Architecture and Design Principles' McGraw Hill Education (India) Private Limited.

Reference Books:

1. Ovidiu Vermesan, Peter Friess, 'Internet of Things – Converging Technologies for Smart Environments and Integrated Ecosystems', River Publishers.

2. Honbo Zhou, 'The Internet of Things in the Cloud', CRC Press(2013).

3. Peter Waher, 'Learning Internet of Things', Packt Publishing (2015).

Online/Web/Other References:

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

2. https://www.edx.org/learn/iot-internet-of-things

3. https://alison.com/course/internet-of-things-and-the-cloud

4. https://online.stanford.edu/courses/xee100-introduction-internet-things

20PECE 801LA Introduction to Natural Language Processing Laboratory

Teaching Scheme

Practical: 2 Hours / Week

Examination Scheme

In Semester: 25 Marks
Oral : 25 Marks
Credits: 1

Prerequisite:

Course Objectives:

To facilitate the learner to

1. develop problem solving abilities for natural language processing

2. apply algorithmic strategies while solving problems

3. develop time and space efficient algorithms

Course Outcomes:

After completion of the course, students will be able to

1. Develop programs for natural language processing applications.

2. Design test cases to solve problems for pervasiveness,embedded security and NLP applications.

Suggestive List of Assignments

Group A

1. Write a program using Scala/ Python/ C++ using Eclipse to correct the spelling of English paragraphs.

Group B (Any two)

Using Programming language Python and Natural Language Tool Kit (NLTK) perform following
1. Apply Simple language processing for 10 phonetics Indian languages (Marathi or mother-tongue)
2. Lab on sentiment analysis
3. Lab on Cross Lingual information retrieval
4. Lab on document summarization

Group C

1. Study and implementation of research paper in Multidisciplinary NLP using open source tool.

20PECE 801LB User Experience Design Laboratory

Teaching Scheme	**Examination Scheme**
Practical: 2 Hours / Week	In Semester: 25 Marks
	Oral : 25 Marks
	Credits: 1

Prerequisite:

Course Objectives:

To facilitate the learner to

1. Understand users' needs, experiences, behaviours and goals.
2. Learn how visual perception affects the viewing experience
3. Explain Why you made design decisions, through presentations of assignments

Course Outcomes:

After completion of the course, students will be able to

1. Discover the techniques used for understanding of users, what they need, what they value, their abilities, and also their limitations
2. Design innovative and user friendly interfaces for mobile and web applications.
3. Criticize existing interface designs, identify areas of improvement and then create better services and products to make user experience better.
4. Discover the industry-standard tools and specific project deliverables in UI/UX

Suggestive List of Assignments

1. Design user persona for the users of selected product / system and Conduct a contextual inquiry for selected product / system.
2. Heuristic evaluation on a computer prototype developed by your classmates.
3. Design of User interface for the system using various interaction styles.
4. Design appropriate icons pertaining to a given domain. (Eg. Greeting cards)
5. Design a Mobile App/Website that can help people to sell their handmade products in metro cities

6. Improve Instagram with a new, innovative feature, which stands out from other image apps.

7. Redesign a page from the job portal you like (preferably a complex screen). Justify your selection and the changes/design you made. Document your design process on Notion.

8. ATM machine/KIOSK screen design for rural people

9. Tool exploration Adobe XD, Figma

20PECE 801LC Multimedia Systems Laboratory

Teaching Scheme

Practical: 2 Hours / Week

Examination Scheme

In Semester: 25 Marks
Oral : 25 Marks
Credits: 1

Prerequisites:

Data Structures Laboratory - 20CE 305

Programming Skills Development-I Laboratory -20CE 306

Course Objectives:

To facilitate the learner to

1. To explore authoring tools and animation tools

2. To learn and understand Text compression.

3. To understand the operations performed on audio, video and image files.

4. To develop presentation package using multimedia concepts.

5. To learn and implement virtual reality scene.

Course Outcomes:

After completion of the course, students will be able to

1. Apply basic knowledge of multimedia systems.

2. Implement analyze text compression algorithm

3. Implement operations on audio, video and image file formats.

4. Develop virtual scene using virtual reality tools.

5. Develop multimedia application.

Preamble:
20PECE 801 lab would be for understanding and applying the Apply basic knowledge of multimedia systems and implementation of some real-world simple applications.Assignment statements are in brief and should be implemented in JAVA/Python programming language.
Group A assignments are on text compression,Audio,study of authoring tool,animation tools.
Group B assignments are on designing Media player, storing and displaying audio visual information.
Group C assignment is on application developement.

Suggestive List of Assignments

Group A :   (Mandatory)

1	Text Compression using Huffman Code.
2	Parsing WAV file and display headers. Merge one file with another and play the output file
3	Read and display BMP file header. Write a program to convert gray BMP file to black and white BMP file
4	Study of authoring tool – (e.g. Director 8), to create presentation using multimedia files.
5	Study of 3D Animator – (e.g. 3D Studio), to create 3D world

Group B: (Any Two)

1	Designing Media player using Java to play files – WAV, VOC, MIDI, AVI files etc.
2	Understanding audio visual information stored in AVI file format and displaying the same as a sequence of images/frames on the screen.
3	Creation of virtual scene using VRML

Group C

1	Developing presentation package which will enable to integrate text, image and sound media (trivialized version of Power Point like application development package) Create a web interface for displaying images from your image database

20PECE 801LD Artificial Intelligence Laboratory

Teaching Scheme

Practical: 2 Hours / Week

Examination Scheme

In Semester: 25 Marks

Oral: 25 Marks

Credits: 1

Prerequisite:

Course Objectives:

To facilitate the learner to

1. Experiment Artificial Intelligence concepts from syllabus.

2. Experiment AI searches like A*, Min-max algorithm.

3. Understand monotonic and non-monotonic knowledge representation.

4. Experiment classification and clustering algorithms.

Course Outcomes:

After completion of the course, students will be able to

1. Implement various uninformed searching techniques.

2. Implement various Heuristic searching techniques.

3. Apply Knowledge Management techniques to implement Expert system.

4. Implement unification for the given expression.

Suggestive List of Assignments

Group A :   (Mandatory)

1. Implement DFS/BFS for graph problem.
2. Implement simple water jug problem using DFS or BFS.
3. Implement Best first search algorithm
4. Implement A* algorithm for graph problem

Group B: (Any Two)

1. Implement A* algorithm for 8 puzzle problem
2. Write a program to implement Min-max algorithm for game playing
3. Implement Unification algorithm

Group C

    1. Represent knowledge using AIML/Prolog by implementing small expert system

20PECE 801LE Internet Of Things Laboratory

Teaching Scheme	Examination Scheme
Practical: 2 Hours / Week	In Semester: 25 Marks
	Oral: 25 Marks
	Credits: 1

Prerequisite:

Course Objectives:

To facilitate the learner to

1. Understand various development boards used for Internet of Things (IoT).

2. Learn and understand the fundamentals of sensor-based applications.

3. Implement and solve the problems using high level language.

4. Develop mini applications on IoT boards with proper design.

Course Outcomes:

After completion of the course, students will be able to

1. Implement Internet of Things on various development boards.

2. Design the minimum system for sensor based application.

3. Solve the problems related to the primitive needs using IoT.

4. Develop IoT application for distributed environment

Suggestive List of Assignments

Group A :   (Mandatory)

1. Study of Raspberry-Pi, Beagle board, Arduino and other micro controller (History & Elevation)

2. Study of different operating systems for Raspberry-Pi /Beagle board. Understanding the process
   of OS installation on Raspberry-Pi /Beagle board.

3. Write an application to read the environment temperature. If temperature crosses a threshold
    value, the application indicated user using LEDSs

4. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with IR sensor. Write an

   application to detect obstacle and notify user using LEDs.

5. Understanding and connectivity of Raspberry-Pi /Beagle board with camera. Write an application to capture and store the image.

Group B: (Any Two)

1. Understanding and connectivity of Raspberry-Pi /Beagle board with a Zigbee module. Write a network application for communication between two devices using Zigbee.

2. Using Thinker cad program Arduino for various small systems.

3. Simulator assignments on Beagle Bone Black

   a. Write an application using Beagle board to control the operation of stepper motor.

   b. Write an application using Beagle board to control the operation of a hardware simulated traffic signal.

   c. Write an application using Beagle board to control the operation of a hardware simulated lift elevator.

4. Assignments on Cloud of Things:

   a. Write a server application to be deployed on Raspberry-Pi /Beagle board. Write client applications to get services from the server application.

   b. Create a small dashboard application to be deployed on cloud. Different publisher devices can publish their information and interested application can subscribe.

   c. Create a simple web interface for Raspberry-Pi/Beagle board to control the connected LEDs remotely through the interface.

5. Use AWS/ IBM Bluemix/ Contineo/ platform - Develop applications on these platforms

Group C

Design a smart system for IoT using your own choices for:

Development board, Sensors, IoT Level, protocol, development platform, operating system etc.

Sample Mini Project Statements:

   1. Develop a Real time application like smart home with following requirements: When

user enters into house the required appliances like fan, light should be switched ON. Appliances should also get controlled remotely by a suitable web interface. The objective of this application is student should construct complete Smart application in group.

2. Develop a Real time application like a smart home with following requirements: If anyone comes at door the camera module automatically captures his image send it to the email account of user or send notification to the user. Door will open only after user's approval.

20PECE 802A Operation Research

Teaching Scheme

Lectures: 3 Hours /week

Examination Scheme

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 3

Prerequisite: Discrete Mathematics (20CE 303)

Course Objectives:

To facilitate the learners to :

1. Identify and characterize situations in which Linear Programming technique can be applied.
2. Derive feasible and optimal solution for Transportation and Assignment Problem.
3. Apply various methods to select and execute various optimal strategies of decision making and to win the game
4. Understand Queuing system model.

Course Outcomes :

By taking this course, the learner will be able to:

1. Apply Linear Programming technique for Operations Research problem
2. Solve Transportation and Assignment Problem
3. Evaluate different methods to compute value of game and decision making
4. Make use of Queuing theory to solve problems

Unit 1: Introduction to Operations Research (06)

A Quantitative Approach to Decision Making, History, Definitions, Features, Approach to Problem Solving. Overview of models and Modelling, Advantages of Model Building, Methods and Methodology, Advantages, Opportunities, features of solutions and Applications of Operations Research.

Unit 2: Linear Programming (08)

Structure of linear programming model, advantages, limitations, application areas, General mathematical model, Guidelines of model formulation, examples of linear programming model formulation, Graphical and Simplex method of Linear Programming.

Unit 3: Transportation and Assignment Problem (07)

Introduction, Mathematical formulation of transportation and assignment problem, initial basic feasible solution, testing for optimality, Modified distribution method, methods of solving assignment problem, unbalanced transportation and assignment problem. Case study : Dispatch model of Amazon and Swiggy

Unit 4: Decision Theory   (07)

Introduction, steps in decision making, Types of decision making environments, Decision making under Uncertainty, Decision making under Risk.

Unit 5: Game Theory   (07)

Introduction, Two-person Zero-Sum Games, Pure Strategy (Games with Saddle Point), Mixed Strategy (Games without Saddle point), The rules of Dominance.

Unit 6: Queuing Theory   (07)

Introduction, The structure of queuing system, Performance measure of queuing system, Probability distributions in queuing systems, Classification of queuing models, Single server M/M/1:∞/FCFS exponential service queuing model.

Text books:

1. J K Sharma, 'Operations Research: Theory and Applications', Trinity Press, (5th Edition),(2013), ISBN: 978-9350-59336-3.
2. P Sankara Iyer, 'Operations Research', Sigma Series, Tata McGraw Hill Publication Private Limited, (4 th Reprint), (2012), ISBN: 978-0-07-066902-4.

Reference Books:

1. S D Sharma, 'Operations Research', Kedar Nath Ram Nath Publication, (15th Edition),(2009), ISBN: 978-81-224-2288-7.
2. Gupta Prem Kumar and Hira D.S., 'Problems in Operations Research', S Chand Publication, (2012), ISBN: 978-8121909686.
3. Hamdy A. Taha, 'Operations Research', Pearson Education, (8 th Edition), (2012), ISBN: 978-81-317-1104-0.

20PECE 802B Distributed Systems

Teaching Scheme
Lectures: 3 Hours / Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

Course Objectives:
To facilitate the learner to
1. To know the emerging trends in Distributed Systems.
2. To have thorough knowledge of Networks & Communication in Distributed Systems.
3. To integrate distributed objects, remote invocation, synchronization, processes and processors of Distributed Systems.
4. To have systematic knowledge of distributed file system, shared memory and security in Distributed Systems.

Course Outcomes:
After completion of the course, students will be able to
1. Apply fundamental concepts of Distributed system to understand working of Distributed Systems
2. Apply communication mechanisms and synchronization algorithms in Distributed Systems
3. Apply consensus mechanism, replication techniques and consistency model in Distributed Systems
4. Explore trends and applications of Distributed Systems

Unit I: Introduction   (6)
Introduction, Examples of distributed systems, Challenges, benefits, transparency, System Models: Physical models, Architectural Models, Fundamental Models, case study-world wide web

Unit II: Communication and messaging   (8)
Types of Communication, Remote Procedural Call- Remote Method Invocation. Message Oriented Communication: Simple Transient Messaging with Sockets, Message Oriented middleware, Brewer's CAP algorithm

Unit III: Time, coordination and agreement   (8)
Physical Clocks, Clock Synchronization Algorithms. Logical Clocks–Lamport's Logical clocks, Vector Clocks. Mutual Exclusion: Overview, Centralized Algorithm, Distributed Algorithm, Token-Ring Algorithm, Decentralized Algorithm, Election Algorithms: Bully Algorithm, Ring Algorithm

Unit IV: Consensus   (6)

Distributed consensus: Consensus in asynchronous systems, Consensus in synchronous systems, Paxo"s algorithm, Failure detectors. Distributed Transactions: Classification of transactions.

Unit V: Consistency and Replication   (8)

Introduction: Reasons for Replication, Replication as Scaling Technique, replica management, architectures, consistency model and protocols, replica placement, Brewer's CAP algorithm, Introduction to Distributed File Systems, File Service Architecture. Case study: HDFS,

Unit VI: Trends and Applications in Distributed Systems   (6)

Trends in distributed system, Map Reduce: Paradigm, Applications, Introduction to Spark, Introduction to Kafka, Peer to Peer Systems in Cloud Computing bit torrent, Grid Computing, Overview of security techniques in distributed systems, Blockchain.

Text Books:
1. George Coulouris, Jean Dollimore, Tim Kindberg, & Gordon Blair, "Distributed Systems – Concept and Design", 5th Edition, Publisher: Pearson, ISBN – 978-13-214301-1.
2. Pradeep K Sinha, "Distributed Operating System", Publisher: PHI. ISBN – 978-81-203-1380-4.
3. Sukumar Ghosh, "Distributed Systems - An Algorithmic approach".

Reference Books:
1. A.D. Kshemkalyani, M. Singhal, "Distributed Computing: Principles, Algorithms, and Systems" ISBN: 9780521189842, Cambridge University Press, March 2011.
2. Nancy Lynch, "Distributed Algorithms" Morgan Kaufmann Publishers, ISBN-13:978-1-55860-348-6
3. Maarten van Steen, Andrew S. Tanenbaum, "Distributed System", Third edition, version 3

Online/Web/Other References:
1. Prof. Rajiv Misra, Distributed System, https://nptel.ac.in/courses/106/106/106106168/#
2. Prof. Rajiv Misra, Cloud computing and Distributed System
3. Prof. Rajiv Misra, Distributed System, https://nptel.ac.in/courses/106/104/106104182/

20PECE 802C Information Retrieval

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hours / Week	In Semester: 50 Marks
	End Semester: 50 Marks
	Credits: 3

Course Objectives:

To facilitate the learner with

1. Concepts of information retrieval
2. Indexing techniques and information retrieval system
3. Text classification and vector space classification
4. The latest trends in information retrieval

Course Outcomes:

After completion of the course, students will be able to

1. Model the working of information retrieval search system
2. Analyze search strategies used in Information retrieval system
3. Design techniques for information retrieval system
4. Understand the latest trends in information retrieval

Unit I: Introduction to Information Retrieval   (7)

Information retrieval process, Indexing, Processing Boolean queries, Term vocabulary and postings lists, document delineation and character sequence decoding, determining vocabulary of terms.

Unit II: Scoring, term weighting and vector space model   (7)

Parametric and zone indexes, Term frequency and weighting, Vector space model for scoring, variant tf-idf functions, Components of an Information retrieval system.

Unit III: Text classification -Naive Bayes and Vector space classification   (7)

Naive Bayes text classification, Bernoulli model, Properties of Naive Bayes, Feature selection, document representation and measures of relatedness in vector spaces, Rocchio classification, KNN, Linear vs Non linear classifiers, Classification with more than two classes, the bias variance tradeoff

Unit IV: Evaluation in Information Retrieval   **(7)**

Information retrieval system evaluation, standard test collections, Evaluation of unranked retrieval sets, evaluation of ranked retrieval sets, Assessing relevance, System quality and user
utility, results snippets.

Unit V: Web search basics and Link Analysis   **(7)**

Web characteristics, advertising as the economic model, The search user experience, Index size and estimation, Near duplicates and shingling, Web crawling and indexes, distributing indexes, connectivity servers. The web as a graph, Page rank, Hubs and authorities

Unit VI: Trends in Information Retrieval   **(7)**

Case study: Google analytics, Search engine optimization, Ranking algorithms,Recommendation systems, Collaborative Filtering

Text Books:

   1.   Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze, Introduction to Information Retrieval, Cambridge University Press. 2008.

Reference Books:

   1.   Grigoris Antoniou and Frank van Harmelen, A semantic Web Primer, Massachusetts

Online/Web/Other References:

   1.   http://nlp.stanford.edu/IR-book/information-retrieval-book.html

20PECE 802D Parallel Computing

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hours / Week	In Semester: 50 Marks
	End Semester: 50 Marks
	Credits: 3

Course Objectives:

To facilitate the learner to

1. Understand the various aspects of the Parallel processing.

2. Familiarize with the fundamental concepts, techniques of parallel computing.

3. Identify advanced computer architectures, parallel algorithms.

4. Evaluate the performance measures of different parallel communication operations.

5. Identify mapping of applications to high-performance computing systems.

6. Understand the advanced trends and techniques in High Performance Computing.

Course Outcomes:

After completion of the course, students will be able to

1. Build the knowledge of different parallel architectures.

2. Identify the different techniques to design parallel solution of the given application.

3. Apply an efficient parallel algorithm to solve a given problem.

4. Compare the advanced techniques in High Performance Computing.

Unit I: Introduction to parallelism   (07)

Need of Parallel Architectures, Parallel Application, Communication Architecture, Shared Address Space, Message Passing, Parallel Architectures, Trends in Microprocessor Architecture, Superscalar Processing, Dichotomy of Parallel Platforms

Unit II: Principles of Parallel Algorithm Design   (07)

Concept of Decomposition, Tasks, Dependency Graphs, Granularity, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing,Interconnection Networks for Parallel Computers.

Unit III: **Basic Communication Operations and Programming Using the Message Passing Paradigm** (07)

Communication Costs in Parallel Machines, One-to-All Broadcast and All-to-One Reduction operations, All-to-All Broadcast and Reduction, All-Reduce Operations, Scatter and Gather,
All-to-All Personalized Communication, Circular Shift Operation, Principles of Message Passing

Unit IV: **Advanced Parallel Algorithms** (07)

Dense matrix algorithms- Matrix Vector Multiplication, Matrix Matrix Multiplication, Sorting -Issues in Sorting on Parallel Computers, Bubble Sort and its Variants, Quicksort, Bucket and Sample Sort, Parallel Depth-First Search, Parallel Best-First Search

Unit V: **Programming Shared Address Space Platforms** (07)

Thread Basics, The POSIX Thread API, The OpenMP Programming Model, Specifying Concurrent Tasks in OpenMP, Synchronization Constructs in OpenMP, Data Handling in OpenMP, OpenMP Library Functions, Evolution of Multicore solution, CUDA Hardware,
Managing GPU memory, CUDA Kernel Function. Cache Coherence in Multiprocessor Systems.

Unit VI: **Recent Trends in Parallel Processing** (07)

Introduction to Petascale Computing, GPU accelerated Deep Learning, High Performance Computing in Data Analytics, Quantum Computing, Energy Efficient Parallel Computing, Parallelization tools.

Case study : Health care & Life Science, Oil & Gas,Telecommunication and smart cities.

Text Books:

1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, 'Introduction to Parallel Computing', Addison-Wesley (India)(Second edition)(2006) , ISBN:0-201-64865-2.

2. David Culler Jaswinder Pal Singh, 'Parallel Computer Architecture: A hardware/Software Approach ', Morgan Kaufmann Publishers (India)(1999) , ISBN 978-1-55860-343-1.

Reference Books:

1. Kai Hwang, 'Scalable Parallel Computing', McGraw Hill (1998) , ISBN:0070317984.

2. Shane Cook, 'CUDA Programming: A Developer's Guide to Parallel Computing with GPUs', Morgan Kaufmann Publishers Inc.(2013) ISBN: 9780124159884.

3. Jason sanders, Edward Kandrot, ' CUDA by Example ', Addison-Wesley , ISBN-13: 978-0-13-138768-3.

Online/Web/Other References:

1. https://nptel.ac.in/courses/106/102/106102114

2. CDAC- Parallel Computing and High Performance Computing

20PECE 802E Introduction to Blockchain

Teaching Scheme

Lectures: 3 Hours / Week

Examination Scheme

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 3

Course Objectives:

To facilitate the learner to

1. Learn the underlying blockchain technology.
2. Learn and Explore blockchain platforms such as Ethereum, Hyperledger to build blockchain applications.
3. Understand use of cryptocurrency and smart contract.
4. Understand use of blockchain in various domains like supply chain management, healthcare, IoT etc.

Course Outcomes:

After completion of the course, students will be able to

1. Apply fundamental concepts of blockchain to understand the working of blockchain.

2. Make use of blockchain platforms such as Ethereum, Hyperledger to build blockchain applications.

3. Make use of Cryptocurrency and Smart Contract in real world applications.

4. Explore applications of Blockchain in domains like supply chain management, healthcare, IoT etc.

Unit I: BLOCKCHAIN FUNDAMENTALS (6)

Basics of Blockchain-Architecture, features, Types (Public, Private, Hybrid), working of blockchain, distributed ledger, wallets, Hash, Consensus mechanism and Mining, Smart contract, cryptocurrency.

Blockchain Technology: Applications, opportunity & challenges.

Unit II: CRYPTOGRAPHY and CONSENSUS MECHANISM (7)

Use of Cryptography in Blockchain, symmetric key and asymmetric-key cryptography algorithms, hash functions, SHA-256, digital signature,merkel trees.

Importance of consensus in transactions. Consensus Mechanisms ex. Proof of Work (PoW), Proof of Stake (PoS), PBFT(Practical Byzantine Fault Tolerance), DBFT(Delegated Byzantine Fault Tolerance).

Unit III: BLOCKCHAIN FRAMEWORKS   **(7)**

Blockchain Platforms like Ethereum and Hyperledger. Demo of Blockchain Tools.
Create nodes on your personal Ethereum blockchain, create accounts, unlock accounts, mine, transact, transfer Ethers, and check balances.

Unit IV: SMART CONTRACT   **(7)**

Introduction, what is smart contract,Working of Smart contract,Challenges. Types of smart contracts, Smart Contracts in Ethereum Blockchain, EVM in relation with Smart Contracts and Gas Price, Demo of Running and Debugging Smart Contracts in Remix (Detailed), Writing smart contracts using Solidity & JavaScript, Deploy and Debug Smart Contract using appropriate tool.

Unit V: CRYPTOCURRENCY   **(8)**

Introduction, Cryptocurrency Basics, wallets, Types of Cryptocurrency. Crypto-economics and Cryptocurrency Transactions, Valid and Invalid Transactions, Cryptocurrency Wallets, Buying Cryptocurrency Wallets , Withdrawal Cryptocurrency Wallets. Mining Blockchain.

Bitcoin, Ethereum basic crypto primitives: Hash, Digital Signatures, Hashchain to Blockchain, Basic consensus mechanisms Ethereum Vs Bitcoin. working of Bitcoin System, Decentralized Cryptocurrency and its use cases. Bitcoin Wallets. Cryptocurrency safety issues.

Unit VI: BLOCKCHAIN APPLICATIONS AND TRENDS   **(7)**

Community, Politics, and Regulation. Stakeholders, Roots of Bitcoin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy. Technical, Business, Cultural, Ethical, and Regulatory Challenges, Regulating and mitigating illegal behaviour(s).
Blockchain Applications like healthcare, Supply Chain Management, Finance, Digital ID's. Real Time Use Cases and Applications in Blockchain.

Blockchain in Financial Service(Payments and Secure Trading, Compliance and Mortgage, Financial Trade).
Blockchain in Government: Advantages, Use Cases. Future trends in blockchain, industry impact. Impact of blockchain on Business.

Text Books:
1. Chandramouli Subramanian, Asha A George, Abhilash K A, Meena Karthikeyan, "Blockchain Technology", Universities Press 2020, ISBN 9789389211634
2. Melanie Swa, "Blockchain", O'Reilly, 2015, ISBN: 9781491920497
3. Bikramaditya Singhal, Gautam Dhameja, Priyanshu Sekhar Panda, "Beginning Blockchain", Apress, First South Asian Edition 2018, ISBN 978-1-4842-3444-0.

Reference Books:
1. Narayanan, Bonneau, Felten, Miller and Goldfeder, "Bitcoin and Cryptocurrency Technologies – A Comprehensive Introduction", Princeton University Press, 2016 ISBN: 9780691171692

2. Thompson, 'Blockchain: The Blockchain for Beginnings, Guide to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017, ISBN: 1546772804

3. Tiana Laurence, Blockchain For Dummies, 2nd edition, Wiley, 2019, ISBN: 978-1-119-55513-1

4. Primavera De Filippi, Aaron Wright, "Blockchain and the Law", Harvard University

   Press, ISBN-13: 978-0674976429

Online/Web/Other References:
1. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric

2. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits
   https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html

3. Prof. Sandip Chakraborty, Dr. Praveen Jayachandran, "Blockchain Architecture Design And Use Cases"[MOOC], NPTEL: https://nptel.ac.in/courses/106/105/106105184/

4. Blog.blockchain.com, https://blog.blockchain.com/category/tutorials/