

# **FACULTY OF ENGINEERING**

## **Scheme of Instruction & Examination**

(AICTE Model Curriculum for the Academic Year 2020-2024)

and

## **Syllabi**

### **B.E. VII and VIII Semesters**

of

### **Four Year Degree Programme**

in

### **B.E. ARTIFICIAL INTELLIGENCE AND DATA SCIENCE**

(With effect from the Academic Year 2023– 2024)



Issued by

**Dean, Faculty of Engineering  
Osmania University, Hyderabad  
2023**

**SCHEME OF INSTRUCTION & EXAMINATION**  
**B.E. VII – SEMESTER**  
**(Artificial Intelligence and Data Science)**

S.No	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	D/P	Contact Hrs/Wk	CIE	SEE	Duration In	
<b>Theory Course</b>										
1.	PC701AD	Deep Learning	3	1	-	4	30	70	3	4
2.	PC702AD	Mining of Massive Datasets	3		-	3	30	70	3	3
3.	PC703AD	Software Management Project	3	-	-	3	30	70	3	3
4.	PE-IV	Professional Elective-IV	3	-	-	3	30	70	3	3
5.	OE-II	Open Elective II	3	-	-	3	30	70	3	3
<b>Practical/Laboratory Course</b>										
6	PC751AD	Deep Learning Lab	-	-	3	3	25	50	3	1.5
7	PC752AD	Mining of Massive Datasets Lab	-	-	3	3	25	50	3	1.5
8	PW761AD	Project Work (Phase-I)	-	-	6	6	50			3
9.	SI671AD	Summer Internship					50			2
<b>Total</b>			15	1	12	28	300	450	21	24

<b>Professional Elective-IV</b>	
<b>Course Code</b>	<b>Course Title</b>
PE741AD	NoSQL
PE742AD	Natural Language Processing
PE743AD	Mobile Computing
PE744AD	Semantic Web
PE745AD	Introduction to Drones

<b>Open Elective–II</b>		
<b>Sl.No</b>	<b>Course Code</b>	<b>Course Title</b>
1.	OE701 EE	Non- Conventional Energy Sources (Not for EEE & EIE)
2.	OE702EE	Transducers and Sensors (Not for EEE & EIE)
3.	OE703AE	Automotive Safety and Ergonomics (Not for Mech./Prod./ Automobile Engg. Students)
4.	OE704ME	Entrepreneurship (Not for Mech./Prod./Automobile Engg. Students)
5.	OE705CE	Principals of Green Building Technologies (Not for Civil Engg. Students)
6	OE706AS	Data Mining (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
7	OE707CS	Web Application Development (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
8	OE708CS	Principles of Python (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
9	OE709AL	Introduction to Deep Learning(Not for CSE, IT , AI&ML,IOT,AI & DS Students)
10	OE710DS	Database Management System(Not for CSE, IT , AI&ML,IOT,AI & DS Students)
11	OE711CB	Privacy & Security in IOT (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
12	OE712 IT	Introduction to Cyber security(Not for CSE, IT , AI&ML,IOT,AI & DS Students)
13	OE713 EC	Fundamentals of IOT (Not for ECE, CSE, IT , AI&ML,IOT,AI & DS Students)
14	OE714 EC	Fundamentals of Neural Networks (Not for ECE, CSE, IT , AI&ML,IOT,AI & DS Students)

**SCHEME OF INSTRUCTION & EXAMINATION**  
**B.E. VIII– SEMESTER**  
**(Artificial Intelligence and Data Science)**

S.No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	D/P	Contact Hrs/Wk	CIE	SEE	Duration In Hrs/Wk	
<b>Theory Course</b>										
1.	PE-V	Professional Elective–V	3		-	3	30	70	3	3
2	OE-III	Open Elective III	3		-	3	30	70	3	3
<b>Practical/Laboratory Course</b>										
3	PW861AD	Project Work-II			16	16	50	100		8
<b>Total</b>			6		16	22	110	240	6	14

<b>Professional Elective–V</b>	
<b>Course Code</b>	<b>Course Title</b>
PE851AD	Data Engineering
PE852AD	Fundamentals of AR and VR
PE853AD	High performance computing
PE854AD	Principles of DevOps
PE855AD	Intellectual Property Rights

<b>Open Elective – III</b>		
S.No.	Course Code	Course Title
1.	OE801 EE	Smart Building Systems ( Not for EEE & EIE)
2.	OE802 EE	Programmable Logic Controllers ( Not for EEE & EIE)
3.	OE803 AE	Automotive Maintenance (Not for Mech./Prod./Automobile Engg. Students)
4.	OE804 ME	Mechatronics ( Not for Mech./Prod./Automobile Engg. Students)
5.	OE805 CE	Essentials of Road Safety Engineering (Not for Civil Engg. Students)
6	OE806 CS	Software Engineering ( Not for CSE, IT , AI&ML,IOT,AI & DS Students)
7	OE 807 AS	Data Visualization (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
8	OE808AL	Human Computer Interaction ( Not for CSE, IT , AI&ML,IOT,AI & DS Students)
9	OE 809DS	Cognitive Science and Analytics (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
10	OE 810 CB	Principles of Blockchain Technologies ( Not for CSE, IT , AI&ML,IOT,AI & DS Students)
11	OE811IT	Mobile Computing (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
12	OE812EC	Principles of Embedded Systems (Not for ECE,CSE, IT , AI&ML,IOT,AI & DS Students)
13	OE813EC	Fundamentals of Fuzzy Logic (Not for ECE,CSE, IT , AI&ML,IOT,AI & DS Students)

## Program Electives For V, VI, VII and VIII SEM

Elective	Sem V	Sem VI		Sem VII	Sem VIII
	PE-I	PE-II	PE-III	PE-IV	PE-V
<b>Data Science</b>	Computer Vision	Data Visualization	Information Retrieval Systems	NoSQL	Data Engineering
<b>AI</b>	Artificial Neural Networks	Human Computer Interaction	Cognitive Science and Analytics	Natural Language Processing	Fundamentals of AR and VR
<b>Computing</b>	Distributed system	Soft Computing	Quantum Computing	Mobile Computing	High performance computing
<b>Web Programming</b>	Web Technologies	Scripting Languages	Web Services	Semantic Web	Principles of DevOps
<b>Networks</b>	Foundation of Cryptography	Blockchain Technologies	Cyber Security	Introduction to Drones	Intellectual Property Rights
<b>General</b>	Internet of Things	Design Thinking	Open Source Tools		

**SCHEME OF INSTRUCTION & EXAMINATION**  
**B.E. VII – SEMESTER**  
**(Artificial Intelligence and Data Science)**

S.No	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	D/P	Contact Hrs/Wk	CIE	SEE	Duration	
<b>Theory Course</b>										
1.	PC701AD	Deep Learning	3	1	-	4	30	70	3	4
2.	PC702AD	Mining of Massive Datasets	3		-	3	30	70	3	3
3.	PC703AD	Software Project Management	3	-	-	3	30	70	3	3
4.	PE-IV	Professional Elective-IV	3	-	-	3	30	70	3	3
5.	OE-II	Open Elective II	3	-	-	3	30	70	3	3
<b>Practical/Laboratory Course</b>										
6	PC751AD	Deep Learning Lab	-	-	3	3	25	50	3	1.5
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	SI671AD	Summer Internship					50			2
<b>Total</b>			15	1	12	28	300	450	21	24

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<b>Course Code</b>	<b>Course Title</b>
PE741AD	NoSQL
PE742AD	Natural Language Processing
PE743AD	Mobile Computing
PE744AD	Semantic Web
PE745AD	Introduction to Drones

<b>Open Elective–II</b>		
<b>Sl.No</b>	<b>Course Code</b>	<b>Course Title</b>
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14	OE714EC	Fundamentals of Neural Networks (Not for ECE, CSE, IT , AI&ML,IOT,AI & DS Students)



Course Code	Course Title				Core/ Elective		
PC701AD	<b>DEEP LEARNING</b>				CORE		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	1	-	-	30	70	4
<p><b>Course Objectives: -</b></p> <ul style="list-style-type: none"> <li>• To introduce the foundations of Artificial Neural Networks</li> <li>• To acquire the knowledge on Deep Learning Concepts</li> <li>• To learn various types of Artificial Neural Networks</li> <li>• To gain knowledge to apply optimization strategies</li> </ul> <p><b>Course Outcomes:-</b></p> <p>By the end of this deep learning course with TensorFlow, the student will be able to</p> <ol style="list-style-type: none"> <li>1. Understand the concepts of Neural Networks</li> <li>2. Apply optimization strategies to implement MLP</li> <li>3. Build deep learning models in TensorFlow and interpret the results</li> <li>4. Understand the Recurrent neural networks</li> <li>5. Build applications in Deep Learning using real-world data</li> </ol>							

### UNIT – I

Deep learning Definition, Difference in between Artificial intelligence, Machine learning, and Deep learning,

**Artificial Neural Networks:** Introduction, Perceptron, XOR Gate, Perceptron Training Rule, Activation Functions

**Linear Neural Networks:** Linear Regression, Implementation of Linear Regression, Softmax Regression, Image Classification Dataset, Implementation of Softmax Regression

### UNIT – II

**Multilayer Perceptrons:** Multilayer Perceptrons, Implementation of Multilayer Perceptrons , Model Selection, Underfitting and Overfitting, Weight Decay, Dropout, Forward Propagation, Backward Propagation and Computational Graphs

**Optimization Algorithms:** Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, Minibatch Stochastic Gradient Descent, Momentum, Learning Rate Adaption : Adagrad, RMSProp, Adam

### UNIT – III

**Introduction to TensorFlow:** What is TensorFlow? - How Does TensorFlow ,Installing TensorFlow - Creating and Manipulating TensorFlow Variables - TensorFlow Operations - Placeholder Tensors - Sessions in TensorFlow - Navigating Variable Scopes and Sharing Variables, Implementing Neural Networks in TensorFlow

**Introduction to Convolutional Neural Networks:** Introduction to CNNs Architecture, Principles behind CNNs.

**Modern Convolutional Neural Networks:** Deep Convolutional Neural Networks (AlexNet),

Networks Using Blocks (VGGNet), Batch Normalization, Residual Networks (ResNet)

#### **UNIT – IV**

**Recurrent Neural Networks:** RNN architecture, Sequence Models, Text Preprocessing, Implementation of Recurrent Neural Networks from Scratch.

**Modern Recurrent Neural Networks:** Gated Recurrent Units (GRU), Long Short Term Memory (LSTM), Deep Recurrent Neural Networks, Encoder-Decoder Architecture

#### **UNIT – V**

**Auto encoders:** Types of Auto Encoders and its applications

**Generative Adversarial Networks:** Generative Adversarial Network, Deep Convolutional Generative Adversarial Networks  
Deep Learning Applications

#### **Suggested Books:**

1. Nikhil Buduma and Nicholas Locascio - Fundamentals of Deep Learning : Designing Next-Generation Machine Intelligence Algorithms – First Edition - O’Reilly , 2017
2. Francois Chollet-Deep Learning with Python-Second Edition,Manning Publications,2017.
3. Josh Patterson and Adam Gibson- Deep Learning: A Practitioner's Approach – First Edition - O’Reilly , 2017
4. Ian Goodfellow, Yoshua Bengio, Aaron Courville - Deep Learning – Second EditionMIT Press -2016

Course Code	Course Title					Core/ Elective	
PC702AD	<b>Mining of Massive Datasets</b>					CORE	
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	-	-	-	30	70	3
<p><b>Course Objectives:-</b></p> <ol style="list-style-type: none"> <li>To understand the statistics used in data mining.</li> <li>To understand methods for mining frequent itemsets, associations</li> <li>To explain methods for clustering, mining data streams and perform link analysis. It covers mining various types of data stores such as spatial, textual, multimedia, streams.</li> <li>To apply mining in social network graphs</li> <li>To demonstrate the application of mining in advertising on web</li> </ol> <p><b>Course Outcomes:-</b></p> <ol style="list-style-type: none"> <li>Recollecting fundamentals of data mining.</li> <li>Extract interesting patterns from large amounts of data.</li> <li>Apply and Evaluate by choosing suitable data mining algorithms for clustering</li> <li>Choose and employ suitable data mining algorithms for mining data streams and link analysis.</li> <li>Acquire knowledge on mining social network graphs and build the case study: Web Advertisement.</li> </ol>							

**Unit-I**

Data Mining: Introduction, Statistical Modeling, Machine Learning, Computational Approaches to Modeling, Feature Extraction, Statistical Limits on Data Mining, Hash Functions, Indexes, Natural Logarithms, Power Laws.

**Unit-II**

Basic Concepts Efficient and scalable Frequent Item sets mining methods, mining various kinds of association rules, association mining to correlation analysis, Apriori Algorithm, FP growth Handling Larger Datasets in Main Memory, Counting Frequent Items in a Stream.

**Unit-III**

Clustering: Introduction to Clustering Techniques, Partitioning Algorithm: K-means Algorithms Hierarchical Clustering: BIRCH algorithm, CURE Algorithm, Density Base Clustering: DBSCAN Algorithm, clustering in Non-Euclidean Spaces, and Clustering for Streams and Parallelism.

**Unit-IV**

Mining Data Streams: The Stream Data Model, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Counting Ones in a Window, Decaying Windows.

Link Analysis: PageRank, Efficient Computation of PageRank, Topic-Sensitive PageRank, Link Spam, Hubs and Authorities

**Unit-V**

Mining Social-Network Graphs Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, Partitioning of Graphs, Finding Overlapping Communities.

**Advertising on the Web:** Issues in On-Line Advertising, On-Line Algorithms, The Matching Problem, The Ad words Problem, Ad words Implementation.

**Suggested Books:**

1. Mining of Massive Datasets - Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman" (LaTeX)
2. Data Mining. Concepts and Techniques, 3rd Edition . Jiawei Han, Micheline Kamber, Jian Pei
3. Data Mining: Introductory and Advanced Topics- Margaret H Dunham Pearson Edition

Course Code	Course Title				Core/ Elective		
PC703AD	<b>SOFTWARE PROJECT MANAGEMENT</b>				CORE		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3
<p><b>Course Objectives:-</b></p> <ul style="list-style-type: none"> <li>To provide sound knowledge in Project Management.</li> <li>To understand the importance of requirement gathering</li> <li>To explore different models in Software Development</li> <li>To know the workflow of a Project</li> <li>To identify various actors in the activity</li> </ul> <p><b>Course Outcomes:-</b> Students are able to</p> <ol style="list-style-type: none"> <li>Understand the activities during the project scheduling of any software application.</li> <li>Learn the risk management activities and the resource allocation for the projects.</li> <li>Apply the software estimation and recent quality standards for evaluation of the software Projects.</li> <li>Acquire knowledge and skills needed for the construction of highly reliable software project.</li> <li>Create reliable, replicable cost estimation that links to the requirements of project planning and managing.</li> </ol>							

**UNIT I:**

Conventional Software Management: The waterfall model, conventional software Management performance.

Evolution of Software Economics: Software Economics, pragmatic software cost estimation.

**UNIT II:**

Improving Software Economics: Reducing Software product size, improving software processes, improving team effectiveness, improving automation, Achieving the required quality, peer inspections.

The old way and the new: The principles of conventional software engineering, principles of modern software management, transitioning to an iterative process.

**UNIT III:**

Life cycle phases: Engineering and production stages, Inception, Elaboration, construction, transition phases.

Artifacts of the process: The artifact sets, Management artifacts, Engineering artifacts, programmatic artifacts. Model-based software architectures: A Management perspective and technical perspective.

**UNIT IV:**

WorkFlows of the process: Software process workflows, Inter trans workflows. Checkpoints of the Process: Major Mile Stones, Minor Milestones, Periodic status assessments. Iterative Process Planning: Work breakdown structures, planning guidelines, cost and schedule estimating, Interaction planning process, Pragmatic planning.

Project Organizations and Responsibilities: Line-of-Business Organizations, Project Organizations, the evolution of Organizations. Process Automation: Automation Building Blocks, The Project Environment.

**UNIT V:**

Project Control and Process instrumentation: The server care Metrics, Management indicators, quality indicators, life cycle expectations pragmatic Software Metrics, Metrics automation. Tailoring the Process: Process discriminants, Example. Future Software Project Management: Modern Project Profiles Next-generation Software economics, modern Process transitions. Case Study: The Command Center Processing and Display System-Replacement(CCPDS-R)

**Suggested Books:**

1. Applied Software Project Management, Andrew Stellman & Jennifer Greene, O'Reilly, 2006  
Head First PMP, Jennifer Greene & Andrew Stellman, O'Reilly,2007
2. Software Engineering Project Management, Richard H. Thayer & Edward Yourdon, second edition, Wiley India, 2004.
3. Agile Project Management, Jim Highsmith, Pearson education, 2004
4. Software Project Management, Walker Royce, Pearson Education, 1998
5. Software Project Management, Bob Hughes & Mike Cotterell, fourth edition, Tata Mc- Graw Hill,2006

**WEB REFERENCES**

<https://www.lynda.com/Project-Management-training-tutorials/39-0.html>

[www.rspa.com/spi/project-mgmt.html](http://www.rspa.com/spi/project-mgmt.html).

Course Code	Course Title				Core/ Elective		
PE741AD	<b>NoSQL</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3
<p><b>Course Objectives:-</b></p> <p>The main objective of this course is to</p> <ul style="list-style-type: none"> <li>• Understand core concepts of NoSQL database and features.</li> <li>• Implement the concept of NoSQL database with various examples</li> <li>• understand NoSQL database tools.</li> </ul> <p><b>Course Outcomes:-</b></p> <p>At the end of the course the student will be able to</p> <ol style="list-style-type: none"> <li>1. Understand the need for NoSQL databases and their characteristics</li> <li>2. Understand the concepts of NoSQL databases</li> <li>3. Implement the concepts of NoSQL databases</li> <li>4. Build the case study using NoSQL database tools.</li> </ol>							

### Unit-I

**Why NoSQL:** The Value of Relational Databases, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL  
 Aggregate Data Models: Aggregates, Column-Family Stores, Summarizing Aggregate Oriented Databases

**More Details on Data Models:** Relationships, Graph Databases, Schemaless Databases, Materialized Views, Modeling for Data Access

### Unit-II

**Distribution Models:** Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication

**Consistency:** Update Consistency, Read Consistency, Relaxing Consistency, Relaxing Durability, Quorums

**Version Stamps:** Business and System Transactions, Version Stamps on Multiple Nodes  
 Map-Reduce: Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations

### Unit-III

**Key-Value Databases:** What Is a Key-Value Store, Key-Value Store Features, Suitable Use Cases, When Not to Use

**Document Databases:** What Is a Document Database, Features, Suitable Use Cases, When Not to Use

**Unit-IV**

Column-Family Stores: What Is a Column-Family Data Store, Features, Suitable Use Cases, When Not to Use

Graph Databases: What Is a Graph Database, Features, Suitable Use Cases, When Not to Use

**Unit-V**

CASE STUDY : NoSQL Database Tools(mongoDB, Neo4j, **Apache Cassandra**)

**Suggested Books:**

1. Pramod J. Sadalage, Martin Fowler. NoSQL Distilled, Addison Wesley 2013

Suggested Reading

2. Luc Perkins, Eric Redmond, Jim R. Wilson. Seven Databases in Seven Weeks. The Pragmatic Bookshelf, 2018

3. Guy Harrison. Next Generation Databases: NoSQL, NewSQL, and Big Data. Apress, 2015.

Course Code	Course Title				Core/ Elective		
PE742AD	<b>Natural Language Processing</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3

**Course Objectives:-**

- Understand the leading trends and systems in natural language processing.
- Understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the above mentioned concepts.
- Identify the significance of pragmatics for natural language understanding.
- Understand the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

**Course Outcomes:**

Students will be able to:

1. Interpret linguistic phenomena and an ability to model them with formal grammars.
2. Apply and analyze proper experimental methodology for training and evaluating empirical NLP systems.
3. Interpret the morphemes, syntax and semantics of a language.
4. Apply probabilistic approaches, construct statistical models over strings and trees and estimate parameters using supervised and unsupervised training methods.
5. Design, implement and apply NLP Algorithms.

**Unit- I**

Introduction: What is Natural Language Processing? NLP tasks in syntax, semantics and pragmatics, Applications such as information extraction, question answering and machine translation. The problem of ambiguity. The role of Machine Learning. Brief history of the field.

**Unit -II**

N-gram Language Models: The role of language models, Simple N-gram models. Estimating parameters and smoothing. Evaluating language models. Parts of Speech Tagging and Sequence Labelling: Lexical Syntax, Hidden Markov Models, Maximum Entropy models and Conditional Random Fields.

**Unit -III**

Syntactic Parsing: Grammar Formalisms and tree banks, Efficient parsing for Context Free Grammars(CFGs), Statistical Parsing and probabilistic CFGs(PCFGs) and Lexicalized PCFGs.

**Unit –IV**

Semantic Analysis: Lexical Semantics and word sense disambiguation, Compositional semantics, Semantic Role Labelling and Sematic Parsing.



**Unit- V**

Information Extraction(IE) and Machine Translation(MT): Named Entity recognition and relation extraction, IE using sequence labelling, Basic issues in Machine Translation. Statistical translation, word alignment, phrase based translation, and synchronous grammars. Dialogues: Turns and utterances Natural Language Generation: Introduction to language generation, architecture, discourse planning, grounding, dialogue acts and structures.

**Suggested Books:**

1. Speech and Language Processing- An introduction to Language Processing, Computational Linguistics, and Speech Recognition, D.Jurafsky, J. H. Martin, Pearson Education.
2. Foundation of Statistical Natural Language Processing, Manning and Schutze.
3. Natural Language Understanding, Allen, James Benjamin/Cummings, 2ed.
4. Natural Language Processing – A Paninian Perspective, Bharathi, A., Vineet Chaitanya and Rajiv
5. Sangal, Prentice Hall India, Eastern Economy Edition.

Course Code	Course Title				Core/ Elective		
PE743AD	<b>MOBILE COMPUTING</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3

**Course Objectives:-**

- To understand basics of wireless voice and data communication technologies.
- To build working knowledge on various telephone and satellite networks.
- To study the working principles of wireless LANs and Standards.
- To gain knowledge on integration of mobile networks into internet.
- To build skills in working with wireless application protocols to develop mobile application.

**Course Outcomes:-**

After completing the course, the student will be able to

1. Understand the various transmission techniques and applications.
2. Differentiate between different telecommunication systems.
3. Implement wireless LAN.
4. Understand Mobile networks, routing concepts.
5. Implement applications for mobile computing.

**UNIT-I**

Introduction – Wireless transmission – Frequencies for radio transmission – Signals – Antennas – Multiplexing –Modulations – Spread spectrum, Cellular Wireless Networks,4G - Introduction, features and challenges, Applications of 4G, 4G Network architecture

**UNIT-II**

Telecommunication systems – GSM – GPRS – DECT – UMTS – IMT-2000 – Satellite Networks - Basics –Parameters and Configurations – Capacity Allocation – FAMA and DAMA – Broadcast Systems – DAB – DVB

**UNIT-III**

Wireless LAN – IEEE 802.11 - Architecture – services – MAC – Physical layer – IEEE 802.11a - 802.11bstandards – HIPERLAN – Blue Tooth.

**UNIT-IV**

Mobile IP, Dynamic Host Configuration Protocol, Routing in MANETs: DSDV, DSR, AODV and ZRP, MANETS vs VANETS

**UNIT-V**

WAP, and WAP 2.0, Mobile Transaction models, File Systems and Mobility Management, Mobile Device Operating Systems – Special Constraints & Requirements, Mobile Payment System – Security Issues

**Suggested Books:**

1. Jochen H. Schiller, "Mobile Communications", Addison Wesley, Second Edition, 2003.
2. William Stallings, "Wireless Communications and Networks", PHI/Pearson Education, 2002.
3. Kaveh Pahlavan, Prasanth Krishnamurthy, "Principles of Wireless Networks", Prentice Hall, 2003.
4. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003.
5. Krzysztof Wesolowski, "Mobile Communication Systems", John Wiley and Sons Ltd, 2002.

Course Code	Course Title				Core/ Elective		
PE744AD	<b>SEMANTIC WEB</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3
<p><b>Course Objectives:-</b></p> <ul style="list-style-type: none"> <li>• To learn Web Intelligence</li> <li>• To learn Knowledge Representation for the Semantic Web</li> <li>• To learn Ontology Engineering</li> <li>• To learn Semantic Web Applications, Services and Technology</li> </ul> <p><b>Course Outcomes:-</b></p> <ol style="list-style-type: none"> <li>1. Understand the characteristics of Semantic Web</li> <li>2. Apply SOAP and UDDI to web services</li> <li>3. Handle multiple web services using Orchestration</li> <li>4. Create documents using XML</li> <li>5. Construct and use Ontologies</li> </ol>							

**UNIT - I**

Introduction: Introduction to Semantic Web, the Business Case for the Semantic Web, XML and Its Impact on the Enterprise.

**UNIT - II**

Web Services: Uses, Basics of Web Services, SOAP, UDDI, Orchestrating Web Services, Securing Web Services, Grid Enabled and Semantic Web of Web Services.

**UNIT - III**

Resource Description Framework: Features, Capturing Knowledge with RDF. XML Technologies: XPath, The Style Sheet Family: XSL, XSLT, and XSL FO, XQuery, XLink, XPointer, XInclude, XMLBase, XHTML, XForms, SVG.

**UNIT - IV**

Taxonomies and Ontologies: Overview of Taxonomies, Defining the Ontology Spectrum, Topic Maps, Overview of Ontologies, Syntax, Structure, Semantics, and Pragmatics, Expressing Ontologies Logically, Knowledge Representation.

**UNIT - V**

Semantic Web Application: Semantic Web Services, e-Learning, Semantic Bioinformatics, Enterprise Application Integration, Knowledge Base. Semantic Search Technology: Search Engines, Semantic Search, Semantic Search Technology, Web Search Agents, Semantic Methods, Latent Semantic Index Search, TAP, Swoogle

**Suggested Books:**

1. The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management by Michael C. Daconta, Leo J. Obrst, Kevin T. Smith, Wiley Publishing, Inc.
2. Thinking on the Web - Berners Lee, Godel and Turing, Wiley Interscience
3. Semantic Web Technologies, Trends and Research in Ontology Based Systems, J. Davies, R. Studer, P. Warren, John Wiley & Sons.
4. Semantic Web and Semantic Web Services - Liyang Lu Chapman and Hall/CRC Publishers, (Taylor & Francis Group)
5. Information Sharing on the semantic Web - Heiner Stuckenschmidt; Frank

Course Code	Course Title					Core/ Elective	
PE745AD	<b>INTRODUCTION TO DRONES</b>					Elective	
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3
<p><b>Course Objectives:-</b> The course should enable the students to:</p> <ul style="list-style-type: none"> <li>To make the students to understand the basic concepts of UAV drone systems.</li> <li>To introduce the stability and control of an aircraft.</li> </ul> <p><b>Course Outcomes:</b> The student should able to:</p> <ol style="list-style-type: none"> <li>Ability to design UAV drone system</li> <li>To understand working of different types of engines and its area of applications.</li> <li>To understand static and dynamic stability dynamic instability and control concepts</li> <li>To know the loads taken by aircraft and type of construction and also construction materials in them.</li> </ol>							

**UNIT-I**

Introduction to Drones: Introduction to Unmanned Aircraft Systems, History of UAV drones, classification of drones, System Composition, applications.

**UNIT II**

Design of UAV Drone Systems: Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects-India Specific, Design for Stealth.

**UNIT III**

Avionics Hardware of Drones: Autopilot, AGL-pressure sensorsservos-accelerometer –gyros-actuators- power supplyprocessor, integration, installation, configuration.

**UNIT IV**

Communication, Payloads and Controls: Payloads, Telemetry, Tracking, controls-PID feedback, radio control frequency range, modems, memory system, simulation, ground test-analysis-trouble shooting.

**UNIT V**

Navigation and Testing: Waypoints navigation, ground control software, System Ground Testing, System In-flight Testing, Future Prospects and Challenge.

**Suggested Books:**

1. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
4. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
5. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics.

Course Code	Course Title				Core/ Elective		
PC751AD	<b>DEEP LEARNING LAB</b>				CORE		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	3	25	50	1.5
<p><b>Course Objectives</b></p> <ul style="list-style-type: none"> <li>• Understand the concepts of Artificial Neural Networks and Deep Learning concepts.</li> <li>• Implement ANN and DL algorithms with Tensorflow and Keras.</li> <li>• Gain knowledge on Sequence learning with RNN.</li> <li>• Gain knowledge on Image processing and analysis with CNN</li> <li>• Get information on advanced concepts of computer vision.</li> </ul> <p><b>Course Outcomes:</b> After learning the concepts of this course, the student is able to</p> <ol style="list-style-type: none"> <li>1. Develop ANN without using Machine Learning/Deep learning library</li> <li>2. Understand the Training ANN model with back propagation</li> <li>3. Develop model for sequence learning using RNN</li> <li>4. Develop image classification model using ANN and CNN.</li> <li>5. Generate a new image with auto-encoder and GAN.</li> </ol>							

**List of Programs:**

1. Create Tensors and perform basic operations with tensors
2. Create Tensors and apply split & merge operations and statistics operations.
3. Design single unit perceptron for classification of iris dataset without using predefined models
4. Design, train and test the MLP for tabular data and verify various activation functions and optimizers  
tensor flow.
5. Design and implement to classify 32x32 images using MLP using tensorflow/keras and check the accuracy.
6. Design and implement a simple RNN model with tensorflow / keras and check accuracy.
7. Design and implement LSTM model with tensorflow / keras and check accuracy.
8. Design and implement GRU model with tensorflow / keras and check accuracy.
9. Design and implement a CNN model to classify multi category JPG images with tensorflow / keras and check accuracy. Predict labels for new images.
10. Design and implement a CNN model to classify multi category tiff images with tensorflow / keras and check the accuracy. Check whether your model is overfit / underfit / perfect fit and apply the techniques to avoid overfit and underfit like regularizers, dropouts etc.
11. Implement a CNN architectures (LeNet, Alexnet, VGG, etc) model to classify multi category Satellite images with tensorflow / keras and check the accuracy. Check whether your model is overfit / underfit / perfect fit and apply the techniques to avoid overfit and underfit.
12. Implement an Auto encoder to de-noise image.
13. Implement a GAN application to convert images.

Course Code	Course Title					Core/ Elective	
PC752AD	<b>MINING OF MASSIVE DATASETS LAB</b>					CORE	
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	3	25	50	1.5
<p><b>Course Objectives</b></p> <p>The course is intended to</p> <ul style="list-style-type: none"> <li>• Obtain hands-on experience using data mining software.</li> <li>• Provide practical exposure of the concepts in data mining algorithms.</li> </ul> <p><b>Course Outcomes:</b></p> <ol style="list-style-type: none"> <li>1. Understand various massive datasets and apply pre-processing Techniques and evaluate with various statistical methods for any given raw data.</li> <li>2. Extract interesting patterns from large amounts of data.</li> <li>3. Choose suitable data mining algorithm for clustering, on data stream and analyse page rank algorithms.</li> <li>4. Discover the role played by data mining in social network and advertising.</li> </ol>							

1. Introduction of various massive datasets and Data streaming tools
2. Implementation of pre-processing Techniques and evaluate with various statistical methods for any given raw data.
3. Implementation of Association rule mining- Apriori Algorithm, FP-Algorithm
4. Implementation of Datastream Algorithm – Bloom Filter
5. Implementation of link analysis algorithms- Page Rank
6. Implementation of clustering algorithms-  
Partitioning Algorithm: K-means Algorithms  
Hierarchical Clustering: BIRCH algorithm, CURE Algorithm,  
Density Base Clustering: DBSCAN Algorithm
7. Case study on -
  - Mining of Social Network
  - Mining of Advertising on the Web



Course Code	Course Title				Core/ Elective		
SI671AD	<b>SUMMER INTERNSHIP</b>				CORE		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	-	-	-	-	50	-	2
<p><b>Course Objectives:-</b> The student should be made to:</p> <ul style="list-style-type: none"> <li>To give an experience to the students in solving real life practical problems with all its constraints.</li> <li>To give an opportunity to integrate different aspects of learning with reference to real life problems.</li> <li>To enhance the confidence of the students while communicating with industry engineers and give an opportunity for useful interaction with them and familiarize with work culture and ethics of the industry.</li> </ul> <p><b>Course Outcomes:- Students will able to do</b></p> <ol style="list-style-type: none"> <li>Able to design/develop a small and simple product in hardware or software.</li> <li>Able to complete the task or realize a pre-specified target, with limited scope, rather than taking up a complex task and leave it.</li> <li>Able to learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to pre-specified criteria.</li> <li>Able to implement the selected solution and document the same</li> </ol>							

Summer Internship is introduced as part of the curricula for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Industry I R & D Organization I National Laboratory for a period of 4 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide.

After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the department. Award of session marks are based on the performance of the student at the work place and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will coordinate the overall activity of Summer Internship.

Course Code	Course Title				Core/ Elective		
PW761AD	<b>PROJECT WORK -PHASE 1</b>				CORE		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	-	-	-	6	50	-	3
<p><b>Course Objectives:</b>  The objectives of this course is to impart knowledge of</p> <ul style="list-style-type: none"> <li>• To enhance practical and professional skills</li> <li>• To familiarize tools and techniques of systematic literature survey and documentation</li> <li>• To expose the students to industry practices and team work.</li> <li>• To encourage students to work with innovative and entrepreneurial ideas</li> </ul> <p><b>Course Outcomes:</b>  After completing this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.</li> <li>2. Evaluate different solutions based on economic and technical feasibility</li> <li>3. Effectively plan a project and confidently perform all aspects of project management</li> <li>4. Demonstrate effective written and oral communication skills</li> </ol>							

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

Collection of project topics/descriptions from faculty members(Problems can also be invited from the industries)

- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills

Obtained in different courses, new technologies and current industry practices .This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide. Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

**Each group will be required to:**

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes' presentation followed by 10 minutes' discussion.
3. Submit a technical write-up on the talk.

Atleast two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity)charts
- Presentation- oral and written.

Course Code	Course Title				Core/ Elective		
OE706AS	<b>DATA MINING</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	-	-	-	30	70	3

**Course Objectives**

- To identify the scope and essentiality of Data warehousing and Data Mining.
- To analyze the data, data science lifecycle, data collection and cleaning, exploratory data analysis and visualization, statistical inference and prediction, and decision-making algorithms for respective applications.
- To develop research interest towards advances in data mining.

**Course Outcomes:** After learning the concepts of this course, the student is able to

- Understand the basic concepts, measures in Data Mining & Data Warehousing
- Understand and Extract knowledge using data preprocessing concepts in data mining
- Extract the hidden pattern using Association Rule mining algorithms
- Classify the data including complex and large datasets using classification algorithms
- Build the model using clustering techniques and solve real world applications using various data mining techniques

**UNIT-I**

Basics of Data Mining : importance of Data Mining, Moving toward the Information Age Data Mining as the Evolution of Information Technology, What Is Data Mining, What Kinds of Data Can Be Mined, Database Data, Data Warehouses, Transactional Data, Other Kinds of Data, OLTP & Online Analytical Processing(OLAP)

**UNIT II:**

Identification of data: Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity: Euclidean, Jaccard's Index & Cosine Similarity Data Pre-processing: Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization

**UNIT-III**

Mining frequent patterns, Associations and correlations: Basic concepts and methods, Frequent Item set, Apriori Algorithm

**UNIT-IV**

Classification: Basic concepts, Decision tree induction, Bayes classification methods, Advance methods, Bayesian Belief Network

**UNIT-V**

Cluster Analysis: Concepts and Methods: Cluster Analysis, Partitioning Methods:K Means, PAM, Outlier Analysis Data Mining Applications, Data Mining and Society, Data Mining trends.

**Suggested Books:**

1. Jiawei Han, Micheline Kamber, Jin Pei, Data Mining: Concepts & Techniques, 3rd Edition., Morgan Koffman ,2011
2. Vikram Pudi, P. Radha Krishna, Data Mining, Oxford University Press, 1st Edition, 2009.
3. Machine Learning and Big Data: Concepts, Algorithms, Tools and Applications-Uma N. Dulhare , Khaleel Ahmad , Khairol Amali Bin Ahmad.
4. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Education,2008.

**SCHEME OF INSTRUCTION & EXAMINATION**  
**B.E. VIII – SEMESTER**  
**(Artificial Intelligence and Data Science)**

S.No	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	D/P	Contact Hrs/Wk	CIE	SEE	Duration In Hrs/Wk	
<b>Theory Course</b>										
1.	OE-III	Open Elective III	3		-	3	30	70	3	3
2	PE-V	Professional Elective–V	3		-	3	30	70	3	3
<b>Practical/Laboratory Course</b>										
3	PW861AD	Project Work-II			16	16	50	100		8
<b>Total</b>			6		16	22	110	240	6	14

<b>Profession Elective–V</b>	
<b>Course Code</b>	<b>Course Title</b>
PE851AD	Data Engineering
PE852AD	Fundamentals of AR and VR
PE853AD	High performance computing
PE854AD	Principles of DevOps
PE855AD	Intellectual Property Rights

<b>Open Elective – III</b>		
<b>S.No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	OE801EE	Smart Building Systems ( Not for EEE & EIE)
2.	OE802EE	Programmable Logic Controllers ( Not for EEE & EIE)
3.	OE803AE	Automotive Maintenance (Not for Mech./Prod./Automobile Engg. Students)
4.	OE804ME	Mechatronics ( Not for Mech./Prod./Automobile Engg. Students)
5.	OE805CE	Essential of Road Safety Engineering (Not for Civil Engg. Students)
6	OE806CS	Software Engineering ( Not for CSE, IT , AI&ML,IOT,AI & DS Students)
7	OE807AS	Data Visualization (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
8	OE808AL	Human Computer Interaction ( Not for CSE, IT , AI&ML,IOT,AI & DS Students)
9	OE809DS	Cognitive Science and Analytics (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
10	OE 810CB	Principles of Blockchain Technologies ( Not for CSE, IT , AI&ML,IOT,AI & DS Students)
11	OE811IT	Mobile Computing (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
12	OE813EC	Principles of Embedded Systems (Not for ECE,CSE, IT , AI&ML,IOT,AI & DS Students)
13	OE814 EC	Fundamentals of Fuzzy Logic (Not for ECE,CSE, IT , AI&ML,IOT,AI & DS Students)

Course Code	Course Title				Core/ Elective		
PE851AD	<b>DATA ENGINEERING</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3
<p><b>COURSE OBJECTIVES:</b></p> <ul style="list-style-type: none"> <li>The objective of this course is to introduce data engineering and role of data engineers.</li> <li>Familiarize students with the basic and advanced techniques of data engineering, data modeling and data acquisition.</li> <li>To learn key techniques of the data modeling framework and Big data tools.</li> <li>To learn categories of API and data science projects using API.</li> </ul> <p><b>Course Outcomes:-</b></p> <p>At the end of this course the student will be able to</p> <ol style="list-style-type: none"> <li>Acquire Knowledge on principles of data engineering</li> <li>Study the data engineering design process to acquire data and develop data modeling methods for their evaluation</li> <li>Explain data engineering frameworks and Big data tools</li> <li>Understand the Categories of API</li> <li>Learn and Understand data science projects using API</li> </ol>							

### UNIT - I Introduction

Data Scientist vs Data Engineer vs Data Analyst – Definition of Data Engineering? – Explaining the Data Pipeline, Data Warehouse and Data Engineer Role – Explaining Data Engineering and Data Warehouse- Building Data Warehouse: Understanding the Data Pipeline – Beyond Data Warehousing: Big Data Engineering – The Role of Data Engineer –The Hierarchy of Analytics – Building Data Foundations & Warehouses – ETL: Extract, Transform, and Load – Choosing ETL Frameworks – Two Paradigms: SQL vs. JVM – Centric ETL.

### UNIT - II Data Acquisition and Data Modelling

Data Acquisition – Data Gathering and Preparation – Data Cleaning – Storage – Data Modeling, Normalization and Star Schema – Data Partitioning by Datestamp– Backfilling Historical Data – Defining the Directed Acyclic Graph (DAG) – Operators: Sensors, Operators and Transfers – ETL Best Practices to follow.

### UNIT - III Data Engineering Frameworks and Big Data Tools

A Common Scenario – From Pipelines To Frameworks – Design Patterns For Data Engineering Frameworks – Incremental Computation Framework – Backfill Framework – Global Metrics Framework – Experimentation Reporting Framework – Data Warehousing / Big Data Tools – Hadoop and MapReduce– Hive and PIG– Apache Spark

### UNIT - IV Categories of API

Overview – Categories of API – Difference between an API and a Library – Walk through an example – 5 APIs – Facebook API – Google Map API – Twitter API – IBM Watson API –Quandl PI



**UNIT - V Data science projects using API**

Data science projects using API – Social Media Sentiment Analysis – Introduction to Sentiment Analysis – Sentiment Analysis Use Cases – Sentiment Classification – Challenges of Sentiment Analysis – Opinion Mining – Applications – Challenges – Stock Prediction

**Suggested Books:**

1. Laura La Bella, “Becoming a Data Engineer”The Rosen Publishing Group, Inc, 2017.
2. Brian Shive, “Data Engineering: A Novel Approach to Data Design”, Technics Publications, October 2013, ISBN: 9781935504603
3. Robert Chang, “A Beginner’s Guide to Data engineering — Part I, Data Engineering: The Close Cousin of Data Science”.
4. “A Beginner’s Guide to Data Engineering — The Series Finale, From ETL Pipelines to Data Engineering Frameworks”.

Course Code	Course Title				Core/ Elective		
PE852AD	<b>FUNDAMENTALS OF AUGMENTED AND VIRTUAL REALITY</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3
<p><b>Course Objectives:-</b></p> <ul style="list-style-type: none"> <li>• To establish and cultivate a broad and comprehensive understanding of AR and VR applications evolving and commercially viable field of Computer Science.</li> </ul> <p><b>Course Outcomes: Students will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Understand fundamental computer vision, computer graphics and human-computer interaction techniques related to AR/VR.</li> <li>2. Understand geometric modelling and Virtual environment.</li> <li>3. Relate and differentiate AR/VR technology.</li> <li>4. Use various types of Hardware and software in Virtual Reality systems</li> <li>5. Implement Virtual/Augmented Reality applications.</li> </ol>							

**UNIT-I**

Introduction to Virtual Reality: Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark.

**UNIT-II**

Computer Graphics And Geometric Modelling: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, Colour theory, Conversion From 2D to 3D, 3D space curves, 3 D boundary representation, Simple 3D modelling, 3D clipping, Illumination models, Reflection models, Shading algorithms. Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection.

**UNIT-III**

Virtual Environment: Input: Tracker, Sensor, Digital Gloves, Movement Capture, Video-based Input, 3D Menus & 3D Scanner etc. Output: Visual /Auditory / Haptic Devices. Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems. Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

**UNIT-IV**

Augmented Reality: Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

**UNIT-V**

Development Tools and Frameworks: Human factors: Introduction, the eye, the ear, the somatic senses. Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML.

**Suggested Books:**

1. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
3. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
4. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
5. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.

Course Code	Course Title					Core/ Elective	
PE853AD	<b>HIGH PERFORMANCE COMPUTING</b>					Elective	
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>To Improve the system performance</li> <li>To learn various distributed and parallel computing architecture</li> <li>To learn different computing technologies.</li> </ul> <p><b>Course Outcomes:</b></p> <ol style="list-style-type: none"> <li>Understanding the concepts in grid computing</li> <li>Ability to set up cluster and run parallel applications</li> <li>Ability to understand the cluster projects and cluster OS</li> <li>Understanding the concepts of pervasive computing &amp; quantum.</li> </ol>							

**UNIT - I**

Grid Computing: Data & Computational Grids, Grid Architectures And Its Relations To Various Distributed Technologies. Autonomic Computing, Examples Of The Grid Computing Efforts (Ibm).

**UNIT - II**

Cluster Setup & Its Advantages, Performance Models & Simulations; Networking Protocols & I/O, Messaging Systems. Process Scheduling, Load Sharing And Balancing; Distributed Shared Memory, Parallel I/O.

**UNIT - III:**

Example Cluster System – Beowlf; Cluster Operating Systems: Compas And Nanos Pervasive Computing Concepts & Scenarios; Hardware & Software; Human – Machine Interface.

**UNIT- IV**

Device Connectivity; Java for Pervasive Devices; Application Examples.

**UNIT - V**

Classical Vs Quantum Logic Gates; One, Two & Three Qubit Quantum Gates; Fredkin & Toffoli Gates; Quantum Circuits; Quantum Algorithms.

**Suggested Books:**

- “Selected Topics In Advanced Computing” Edited By Dr. P. Padmanabham And Dr. M.B. Srinivas, 2005 Pearson Education.
- J. Joseph & C. Fellenstien: ‘Grid Computing’, Pearson Education
- Marivesar: ‘Approaching quantum computing’, Pearson Education.
- Raj kumar Buyya: ‘High performance cluster computing’, Pearson Education.
- Neilsen & Chung L: ‘Quantum computing and Quantum Information’, Cambridge University Press.

Course Code	Course Title				Core/ Elective		
PE854AD	<b>PRINCIPLES OF DevOps</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3
<b>COURSE OBJECTIVES:</b>							
<ul style="list-style-type: none"> <li>Describe the agile relationship between development and IT operations.</li> <li>Understand the skill sets and high-functioning teams involved in DevOps and related methods to reach a continuous delivery capability.</li> <li>Implement automated system update and DevOps lifecycle.</li> <li>Learn core concepts of container orchestration using Kubernetes.</li> </ul>							
<b>Course Outcomes:-</b> The students will be able to:							
<ol style="list-style-type: none"> <li>Identify components of DevOps environment.</li> <li>Describe Software development models and architectures of DevOps, source code management</li> <li>Learn Jenkins continuous Integration tool.</li> <li>Understand automation testing environment.</li> <li>Understand Container orchestration using Kubernetes.</li> </ol>							

**UNIT - I**

Introduction: Introduction, Agile development model, DevOps, and ITIL. DevOps process and Continuous Delivery, Release management, Scrum, Kanban, delivery pipeline, bottlenecks, examples

**UNIT - II**

Software development models and DevOps: DevOps Lifecycle for Business Agility, DevOps, and Continuous Testing.

Introduction to project management: The need for source code control, The history of source code management, Roles and code, source code management system and migrations, Shared authentication, Hosted Git servers, Different Git server implementations, Docker intermission, Gerrit, The pull request model, GitLab.

**UNIT – III**

Integrating the system: Build systems, Jenkins build server, Managing build dependencies, Jenkins plugins, and file system layout, The host server, Build slaves, Software on the host, Triggers, Job chaining and build pipelines, Build servers and infrastructure as code, Building by dependency order, Build phases, Alternative build servers, Collating quality measures.

**UNIT – IV**

Testing Tools and automation: Various types of testing, Automation of testing Pros and cons, Selenium - Introduction, Selenium features, Regression testing, Testing backend integration points, Test-driven development, REPL-driven development

Deployment of the system: Deployment systems, Virtualization stacks, code execution at the client, Puppet master and agents, Ansible, Deployment tools: Chef, Salt Stack and Docker.

**UNIT – V**

Container Orchestration using Kubernetes: Introduction to Container Orchestration, Kubernetes Core Concepts ,Understanding Pods, ReplicaSet and Replication Controller, Deployments, DaemonSets, Rolling Updates and Rollbacks , Scaling Application.

**Suggested Books:**

1. Joakim Verona. Practical Devops, Second Edition. Ingram short title; 2nd edition (2018). ISBN10: 1788392574
2. Deepak Gaikwad, Viral Thakkar. DevOps Tools from Practitioner's Viewpoint. Wiley publications. ISBN: 9788126579952
3. Marko Luksa, Kubernetes in Action, 2<sup>nd</sup> edition(2018), Manning Publishers.
4. Len Bass, Ingo Weber, Liming Zhu. DevOps: A Software Architect's Perspective. Addison Wesley; ISBN-10.

Course Code	Course Title				Core/ Elective		
PE855AD	<b>INTELLECTUAL PROPERTY RIGHTS</b>				Elective		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	0	-	-	30	70	3

**COURSE OBJECTIVES:**

To make students to

- Motivate to choose research as career
- Formulate the research problem, prepare the research design
- Identify various sources for literature review and data collection report writing
- Equip with good methods to analyse the collected data
- Know about IPR copyrights

**Course Outcomes:-**

At the end of this course, students will be able to:

1. Define research problem, review and assess the quality of literature from various sources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various research designs
3. Collect the data by various methods: observation, interview, questionnaires
4. Analyze problem by statistical techniques: ANOVA, F-test, Chi-square
5. Understand apply for patent and copyrights

**UNIT - I**

Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods Verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem

**UNIT - II**

Literature Survey and Report writing: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Need of Review, Guidelines for Review, Record of Research Review.

**Report writing:** Meaning of interpretation, layout of research report, Types of reports, Mechanism of writing a report. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

**UNIT - III**

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.

**UNIT - IV**

Data Collection and Analysis: Methods of data collection, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Importance of Parametric, nonparametric test, testing of variance of two normal populations, use of Chi-square, ANOVA, F-test, z-test

**UNIT - V**

Intellectual Property Rights: Meaning, Nature, Classification and protection of Intellectual Property, The main forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, Granting of patent, Rights of a patent, Licensing, Transfer of technology.

**Suggested Books:**

1. C.R Kothari, Research Methodology, Methods & Techniques; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publications Pvt. Ltd., New Delhi, 2004
4. G.B. Reddy, Intellectual Property Rights and the Law 5th Ed. 2005 Gogia Law Agency
5. Ajit Parulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd, 2006



Course Code	Course Title				Core/ Elective		
PW861AD	<b>PROJECT WORK -PHASE II</b>				<b>CORE</b>		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	-	-	-	<b>16</b>	<b>50</b>	<b>100</b>	<b>8</b>
<b>Course Objectives</b> <ul style="list-style-type: none"> <li>To enhance practical and professional skills</li> <li>To familiarize tools and techniques of systematic Literature survey and documentation</li> <li>To expose the students to industry practices and team work.</li> <li>To encourage students to work with innovative and entrepreneurial ideas</li> </ul>							
<b>Course Outcomes</b> By the end of this course, the students will be able to <ol style="list-style-type: none"> <li>Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems.</li> <li>Evaluate different solutions based on economic and technical feasibility</li> <li>Effectively plan a project and confidently perform all aspects of project management</li> <li>Demonstrate effective written and oral communication skills</li> </ol>							

The aim of Project work –II is to implement and evaluate the proposal made as part of Project Work - I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

- Re-grouping of students - deletion of internship candidates from groups made as part of project Work-I
- Re-Allotment of internship students to project guides
- Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1st week of VIII semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for 25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

**Note: Three periods of contact load will be assigned to each project guide.**

Course Code	Course Title				Core/ Elective		
OE807AS	<b>DATA VISUALIZATION</b>				CORE		
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	p			
	3	-	-	-	30	<b>70</b>	<b>3</b>
<p><b>Course Objectives</b> The objectives of the course are:</p> <ul style="list-style-type: none"> <li>• To learn different statistical methods for Data visualization.</li> <li>• To learn basics of R and Python.</li> <li>• To learn usage of Watson studio.</li> <li>• To learn about packages Numpy, pandas and matplotlib.</li> <li>• To learn functionalities and usages of Seaborn.</li> </ul> <p><b>Course Outcomes</b> After the completion of the course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Apply statistical methods for Data visualization.</li> <li>2. Gain knowledge on R and Python</li> <li>3. Understand usage of various packages in R and Python.</li> <li>4. Demonstrate knowledge of Watson studio.</li> <li>5. Apply data visualization tools on various data sets.</li> </ol>							

**UNIT I**

**Introduction to Statistics:** Introduction to Statistics, Difference between inferential statistics and descriptive statistics, Inferential Statistics- Drawing Inferences from Data, Random Variables, Normal Probability Distribution, Sampling, Sample Statistics and Sampling Distributions. R overview and Installation- Overview and About R, R and R Studio Installation, Descriptive Data analysis using R, Description of basic functions used to describe data in R.

**UNIT II**

**Data manipulation with R:** Data manipulation packages, Data visualization with R. Data visualization in Watson Studio: Adding data to data refinery, Visualization of Data on Watson Studio.

**UNIT III**

**Python:** Introduction to Python, How to Install, Introduction to Jupyter Notebook, Python scripting basics, Numpy and Pandas.

**UNIT IV**

**Data Visualization Tools in Python-** Introduction to Matplotlib, Basic plots using matplotlib, Specialized Visualization Tools using Matplotlib, Advanced Visualization Tools using Matplotlib Waffle Charts, Word Clouds.

**UNIT V**

Introduction to Seaborn: Seaborn functionalities and usage, Spatial Visualizations and Analysis in Python with Folium, Case Study.

**Suggested Books:**

1. Core Python Programming - Second Edition, R. Nageswara Rao, Dream tech Press.
2. R Graphics Essentials for Great Data Visualization by Alboukadel Kassambara.