VI SEMESTER

Scheme of Instruction & Examination

B. E. – Artificial Intelligence and Data Science

AI&DS Semester - VI

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P/D	Contact Hours/ week	CIE	SEE	
Theory Courses									
1	1PC610AD	Computer Networks	3	0	0	3	40	60	3
2	1PC611AD	Machine Learning	3	0	0	3	40	60	3
3	1PC612AD	Automata Languages and Compiler Design	3	0	0	3	40	60	3
4	1PE6(06 to 10) AD	Professional Elective – II	3	0	0	3	40	60	3
5	OE	Open Elective – II	3	0	0	3	40	60	3
6	1HS652HS	Effective Technical Communication	2	0	0	2	40	60	2
Practical / Laboratory Courses									
7	1PC661AD	Machine Learning Lab	0	0	2	2	40	60	1
8	1PC662AD	Data Visualization Lab	0	0	2*2	4	40	60	2
9	1PW663AD	MiniProject	0	0	2	2	40	60	1
Total Credits						**26**	**360**	**540**	**21**

Professional Elective - II

1	1PE606AD	Digital Forensics
2	1PE607AD	Information Retrieval Systems
3	1PE608AD	Software Project Management
4	1PE609AD	Web Technology
5	1PE610AD	Distributed Databases

Open Elective – II

1OE60XXX	Open Elective - II	Offered by
1	Green Building Technologies	CIVIL
2	Software Engineering	CSE
3	Deep Learning	AI&DS
4	Electric Vehicle Technology	EEE
5	Fundamentals of IOT	ECE
6	3D Printing	MECH

Course Code	Course Title						Core/Elective
1PC610AD	COMPUTER NETWORKS						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	-	-	-	2	40	60	1

COURSE OBJECTIVES :

1. To provide a conceptual foundation for the study of data communications using the open Systems interconnect (OSI) model for layered architecture.
2. To study the principles of network protocols and internetworking.
3. To understand the Network security and Internet applications.
4. To understand the performance of data link layer protocols for error and flow control.
5. To understand various routing protocols and network security.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Understand and explain the concept of Data Communication and networks, layered architecture and their applications.
2. Evaluate data communication link considering elementary concepts of data link layer protocols for error detection and correction.
3. Interpret the network layer, routing protocols and analyse how to assign the IP addresses for the given network.
4. Examine the Transport layer services and protocols.
5. Comprehend the functionality of application layer.

UNIT - I

Introduction to Data communication : Representation of data communication, flow of networks, Network Types: LAN, WAN, MAN. Network Topologies: Bus, Star, Ring, Hybrid. Line configurations. Reference Models: OSI, TCP/IP, Transmission media

Techniques for Bandwidth utilization : Multiplexing –Frequency division, time division and wave division, Asynchronous and synchronous transmission.

UNIT - II

Data Link Layer : Framing, Error Detection and Correction: Fundamentals, Block coding, Hamming Distance, CRC.

Flow Control and Error Control Protocols : Stop and Wait, go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, HDLC.

Multiple Access Protocols : ALOHA, CSMA, CSMA/CD, CSMA/CA.

UNIT - III

The Network Layer in Internet : IPV4, IPV6, IP Addressing, NAT.

Internet Networking : Tunnelling, Fragmentation, Congestion Control (Leaky Bucket and Token Bucket Algorithm), and Internet control protocols: ARP, RARP and DHCP.

UNIT - IV

Network Layer : Switching Techniques (Circuit and Packet) concept, Network layer Services, Sub-netting concepts

Routing algorithms : Shortest Path Routing, Flooding, Hierarchical routing, Broadcast, Multicast, Distance Vector Routing

UNIT - V

Transport Layer : Transport Services, Elements of Transport Layer, Connection management, TCP and UDP protocols, QoS improving techniques.

Application Layer: Domain Name System, SNMP, SMTP, HTTP, Bluetooth

TEXT BOOKS

1. "Computer Networks," Andrew S Tanenbaum, V Edition, Pearson Education, 2011.
2. "Data Communication and Networking,"Behrouz A. Forouzan, IV Edition, TMH, 2008.
3. "Data and Computer Communications," William Stallings, VIII Edition, PHI, 2004.

REFERENCE BOOKS

1. "Computer Networks and Internet", Douglas EComer, Pearson Education Asia, 2000.
2. "Data Communications and Computer Networks", PrakashC. Gupta, PHI learning, 2013.

Course Code	Course Title						Core/Elective
1PC611AD	MACHINE LEARNING						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To learn the concepts of machine learning and types of learning along with evaluation metrics.
2. To study various supervised learning algorithms.
3. To learn ensemble techniques and various unsupervised learning algorithms.
4. To explore Neural Networks and Deep learning basics.
5. To learn reinforcement learning and study applications of machine learning

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Extract features that can be used for a particular machine learning approach in various applications.
2. Compare and contrast pros and cons of various machine learning techniques and to get an insight when to apply particular machine learning approach.
3. Understand different machin elearning types along with algorithms.
4. Understand how to apply machin elearning in various applications.
5. Apply ensemble techniques for improvement of classifiers.

UNIT - I

Introduction : Representation and Learning: Feature Vectors, Feature Spaces, Learning Problem Formulation

Types of Machine Learning Algorithms : Parametric and Non-parametric Machine Learning Algorithms, Supervised, Unsupervised, Semi-Supervised and Reinforced Learning.

UNIT - II

SupervisedAlgorithms :

Regression : Linear Regression, Logistic Regression, Evaluation Measures : SSE,

RMSE, R2. Classification : Decision Tree, Naïve Bayes, K-Nearest Neighbors, Support Vector Machines, Over fitting, Training, Testing, and Validation Sets.

Accuracy Metrics : The Confusion Matrix, precision, recall, F-Score, Receiver Operator Characteristic (ROC) Curve.

UNIT - III

Feature Selection and Dimensionality Reduction

Ensemble Algorithms : Bagging, Random Forest, Boosting

Unsupervised Learning : Cluster Analysis : Similarity Measures, categories of clustering algorithms, k-means, Hierarchical, Expectation -Maximization Algorithm, Fuzzy c-means algorithm

UNIT - IV

Neural Networks : Multilayer Perceptron, Activation Functions.

Training strategies : Back-propagation algorithm, Gradient Descent.

Radial basis functions, Hopfield network, Recurrent Neural Networks.

UNIT - V

Reinforcement Learning : overview, example : gettinglost, State and Action Spaces, The Reward Function, Discounting, Action Selection, Policy, Markov decision processes Q-learning, uses of Reinforcement learning Applications of Machine Learning in various fields: Text classification, ImageClassification,Speech Recognition

TEXT BOOKS

1. Machine Learning & Pattern Recognition (2014) Tom Mitchell, Machine Learning, McGraw-Hill Science/Engineering/Math; (1997).
2. Stephen Marsland, Machine Learning : An Algorithmic Perspective, Second Edition Chapman & Hall/CRC Press.

REFERENCE BOOKS

1. Kevin Murphy, Machine Learning : A Probabilistic Perspective, MIT Press, 2012.

Course Code	Course Title						Core/Elective
1PC612AD	AUTOMATA LANGUAGES AND COMPILERDESIGN						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. Introduce the concept of formal specification of languages and different classes of formal languages.
2. Discuss automata models corresponding to different levels of Chomsky hierarchy.
3. Analyze and explain the behavior of push-down automata and TM.
4. Toteach concepts of language translation and phases of compiler design.
5. To inculcate knowledge of parser by parsing LL parsera nd LR parser.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Explain finite state machines for modeling and their power to recognize the languages.
2. Summarize the concept of Regular languages and context free languages.
3. Construct PDA and Turing machines for the given set of languages.
4. Build the lexical and Syntax analyser phases of compiler.
5. Model SDD's using Intermediate Representations.

UNIT - I

Formal Language and Regular Expressions : Languages, Definition Languages regular expressions, Finite Automata – DFA, NFA. Conversion of regular expression to NFA, NFA to DFA. Finite automata with output – Moore and Mealymachines, conversion of Moore to Mealy and Mealy to Moore.

UNIT - II

Context Free grammars and parsing : Context free grammars, derivation, parse trees, ambiguity, Leftmost and rightmost derivation of strings and Sentential forms,

Ambiguity, left recursion and left factoring in context free grammars, Minimization of context free grammars, Normal forms for context free grammars, Chomsky normal form

Pushdown Automata: Introduction to Pushdown automata, Acceptance of context free languages, Acceptance by final state and acceptance by empty state and its equivalence, Equivalence of context free grammars and pushdown automata.

UNIT - III

Turing Machine: Introduction to Turing Machine, Design of Turing machines, Types of Turing machines.

Introduction to Compiling : Overview of Compilers, Phases of a Compiler.

Lexical Analysis: The Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, LEX tool.

UNIT - IV

Syntax Analysis : The roleof theParser, Firstand Follow,Predictive Parsing

Bottom up parsing: Shift reduce parsing,LR Parsers-SLR,Canonical LR, LALR, Parser Generator (YACC).

Semantic Analysis : Syntax directed translation, S-attributed and L-attributed grammars.

Intermediate code generation – abstract syntax tree, Three address code, Implementations

UNIT - V

Run time storage : Storage organization, storage allocation strategies

Code optimization : Optimization of basic blocks, peephole optimization, flow graphs, Data flow analysis of flow graphs.

Code generation : Machine dependent code generation, Register allocation and assignment. Using DAG representation of Block.

TEXT BOOKS

1. "Introduction to Automata Theory Languagesand Computation", John E Hopcroft, Rajeev Motwani, Jeffrey D.Ullman, III Edition, Pearson Education, 2011.
2. "Compilers - Principles Techniques and Tool", Alfred Aho, Monica SLam, Ravi Sethi, Jeffrey D.Ullman, II Edition, Pearson Education India, 2013.

REFERENCE BOOKS

1. "An introduction to Formal Languages and Automata", PeterLinz, VI Edition, Jones & Bartlett, 2016
2. "Principles of Compiler Design", V.Raghavan, I Edition, McGrawHill Education, 2017.
3. "Theory of Computer Science – Automata Languages and Computation", Mishra and Chandrashekaran, III Edition, PHI, 2009
4. "Formal Languages and Automata Theory", K.V.N.Sunitha,N.Kalyani, IEdition, TMH, 2010
5. "Introduction to Theory of Computation", Michel Sipser, II Edition, Thomson, 2012.

Course Code	Course Title						Core/Elective
1PE606AD	DIGITAL FORENSICS						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
2. To understand how to examine digital evidences such as the data acquisition, identification analysis.
3. Understand the processing crimes and incident scenes
4. Understand the latest computer forensic tools.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Apply forensic analysis tools to recover important evidence for identifying computer crime.
2. Understand computing investigation
3. Understand the perspective of data acquisition tools
4. Understand the process of digital crimes
5. Understand the latest computer forensic tools.

UNIT - I

Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.

UNIT II

Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.

UNIT - III

Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions,

performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.

UNIT - IV

Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.

UNIT - V

Current computer forensics tools- software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.

TEXTBOOKS

1. "Computer Forensics: Incident Response Essentials", Warren G. Kruse II and Jay G. Heiser, ,Addison Wesley, 2002.
2. "Guide to Computer Forensics and Investigations, Nelson, B, Phillips, A, Enfinger, F, Stuart, C., II Edition, Thomson Course Technology, 2006, ISBN: 0-619-21706-5.

REFERENCE BOOKS

1. Computer Forensics, Computer Crime Scene Investigation, Vacca, J,II Edition, Charles River Media, 2005, ISBN: 1-58450-389.

Course Code	Course Title						Core/Elective
1PE607AD	INFORMATION RETRIEVAL SYSTEMS						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To learn the different models for information storage and retrieval
2. To learn about the various retrieval utilities
3. To understand indexing and querying in information retrieval systems
4. To expose the students to the notions of structured and semi structured data
5. To learn about web search

COURSE OUTCOMES:

After the completion of course the students will be able to:

1. Understands to store and retrieve textual documents using appropriate models
2. Uses the various retrieval utilities for improving search.
3. Understands the indexing and compressing documents to improve space and time efficiency formulates SQL like queries for unstructured data.
4. Understands issues in web search.

UNIT - I

Introduction, Retrieval Strategies : Vector space model, Probabilistic retrieval strategies: Simple term weights, Non binary independence model, Language Models.

UNIT - II

Retrieval Utilities: Relevance feedback, Clustering, N-grams, Regression analysis, Thesauri.

UNIT - III

Retrieval Utilities: Semantic networks, Parsing

Cross-Language Information Retrieval: Introduction, Crossing the language barrier.

UNIT - IV

Efficiency: Inverted index, Query processing, Signature files, Duplicate document detection.

UNIT - V

Integrating Structured Data and Text: A Historical progression, Information retrieval as a relational application, Semi-structured search using a relational schema

Distributed Information Retrieval: A Theoretical model of distributed retrieval, Web search.

TEXTBOOKS

1. Information Retrieval - Algorithms and Heuristics, Springer, David A. Grossman, Ophir Frieder, II Edition (Distributed by Universities Press),

REFERENCE BOOKS

1. Information Storage and Retrieval Systems, Gerald J Kowalski, Mark T Maybury, Springer, 2000.
2. Mining the Web: Discovering Knowledge from Hypertext Data, Soumen Chakrabarti, Morgan-Kaufmann Publishers, 2002.
3. An Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Cambridge University Press, Cambridge, England, 2009.

Course Code	Course Title						Core/Elective
1PE608AD	SOFTWARE PROJECT MANAGEMENT						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To understand software project planning and evaluation techniques.
2. To plan and manage projects at each stage of the software development lifecycle (SDLC)
3. Tolearnabouttheactivityplanningandriskmanagementprinciples.
4. To acquires kills to manage various phases involved in project management and people management.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Understand the basic project management concepts, framework and the process models
2. Apply appropriate software process model and software effort estimation techniques
3. Estimate risks involved in various project activities, staff and issues related to people management
4. Analyze checkpoints, project reporting structure, project progress and tracking mechanisms using project management principles.

UNIT - I

PROJECTEVALUATIONANDPROJECTPLANNING

Importance of Software Project Management – Activities – Methodologies – Categorization of Software Projects – Setting objectives – Management Principles – Management Control – Project portfolio Management – Cost-benefit evaluationtechnology – Risk evaluation – Strategic program Management – Stepwise Project Planning.

UNIT - II

PROJECTLIFECYCLEANDEFFORTESTIMATION

Software process and Process Models – Choice of Process models – Rapid Application development – Agile methods – Dynamic System Development Method

– Extreme Programming– Managing interactive processes – Basics of Software estimation – Effort and Cost estimation techniques – COSMIC Full function points – COCOMO II – a Parametric Productivity Model

UNIT - III

ACTIVITY PLANNING AND RISK MANAGEMENT

Objectives of Activity planning – Project schedules – Activities – Sequencing and scheduling – Network Planning models – Formulating Network Model – Forward Pass & Backward Pass techniques – Critical path (CRM) method – Risk identification –Assessment – Risk Planning –Risk Management – – PERT technique – Monte Carlo simulation – Resource Allocation – Creation of critical paths – Cost schedules.

UNIT - IV

PROJECT MANAGEMENT AND CONTROL

Framework for Management and control – Collection of data – Visualizing progress –Costmonitoring–EarnedValueAnalysis–PrioritizingMonitoring–Projecttracking– Change control – Software Configuration Management – Managing contracts – ContractManagement

UNIT - V

STAFFING IN SOFTWARE PROJECTS

Managingpeople –Organizational behavior –Best methodsof staff selection– Motivation– The Oldham – Hackman job characteristic model – Stress – Health and Safety – Ethicaland Professional concerns – Working in teams – Decision making – Organizationalstructures – Dispersed and Virtual teams – Communications genres – Communicationplans – Leadership.

TEXT BOOKS

1. Software Project Management, Bob Hughes, Mike Cotterell and Rajib Mall, V Edition Tata McGrawHill, NewDelhi, 2012.
2. Effective Software Project Management, RobertK.Wysocki, Wiley Publication, 2011.

REFERENCE BOOKS

1. SoftwareProjectManagement, WalkerRoyce, Addison-Wesley,1998.
2. Managing Global Software Projects, Gopalaswamy Ramesh, McGraw HillEducation (India), Fourteenth Reprint 2013.

Course Code	Course Title						Core/Elective
1PE609AD	WEB TECHNOLOGY						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES:

1. To understand the technologies used in Web Programming.
2. To know the importance of object-oriented aspects of Scripting.
3. To understand creating database connectivity using JDBC.
4. To learn the concepts of web-based application using sockets.

COURSE OUTCOMES:

After the completion of course the students will be able to:

1. Apply the concepts of PHP in creating web pages and connecting to database (My sql)
2. Apply the concepts of XML for structuring the web pages.
3. Make use of Servlets to create dynamic web pages in client-server architecture.
4. Make use of JSP to develop interactive web pages.
5. Apply the techniques of Java script in client side scripting.

UNIT - I

HTML Common tags - List, Tables, images, forms, Frames; Cascading Style sheets.

Client-side Scripting : Introduction to Javascript, Javascript language - declaring variables, scope of variables, functions. Event handlers (onclick, onsubmit etc.), Document Object Model, Form validation.

UNIT - II

XML: Introduction to XML, Defining XML tags, their attributes and values, Document Type Definition, XML Schemes, Document Object Model, XHTML Parsing XML Data - DOM and SAX Parsers in java.

UNIT - III

Introduction to PHP: Declaring variables, data types, arrays, strings, operators, expressions, control structures, functions, Reading data from web form controls like text boxes, radio buttons, lists etc.,

Handling in PHP : File operations like opening, closing, reading, writing, appending, deleting etc. on text andbinary files, listing directories.

UNIT - IV

Introduction to Servlets : Common Gateway Interface (CGt), Life cycle of a Servlet, deploying a servlet, TheServlet API, Reading Servlet parameters, Reading Initialization parameters, Handling Http Request & Responses, Using Cookies and Sessions, connecting to a database using JDBC.

UNIT - V

Introduction to JSP: The Anatomy of a JSP Page, JSP Processing, Declarations, Directives, Expressions, Code Snippets, implicit objects, Using Beans in JSP Pages, Using Cookies and session for session tracking,connecting to database in JSP

TEXT BOOKS

1. Internet and World Wide Web: How to Program,Harvey Deitel, Abbey Deitel, V Edition.
2. Java - The Complete Reference, Herbert Schildt, VII Edition. Tata McGraw- Hill Edition.
3. XML Unleashed,Michael Morrison,Tech media SAMS.

REFERENCE BOOKS

1. Javascript - A Beginners Guide, John Pollock,III Edition – Tata McGraw-Hill Edition.
2. Gateway to Java Programmer Sun Certification, Keyur Shah,Tata McGraw Hill, 2002.

Course Code	Course Title						Core/Elective
1PE610AD	DISTRIBUTED DATABASES						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To introduce data base system and need of distributed database technology.
2. To acquire the knowledge on Database design and query processing.
3. To learn Distributed Concurrency control mechanism and algorithms.
4. To understand the concept of Distributed Database reliability and Distributed Object Database Management.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Able to identify various design issues and architectural models.
2. Able to analyse the query to process the data.
3. Able to understand the concurrency control algorithms.
4. Able to understand the reliability protocols of distributed database.
5. Able to improve application programmer productivity.

UNIT - I

Distributed Data Processing, Distributed Database Systems, Promises of DDBSs, Distributed Database Design, Distributed Directory Management, Distributed Query Processing, Distributed Concurrency Control, Distributed Deadlock Management, ANSI/SPARC Architecture, A Generic Centralized DBMS Architecture , Architectural Models for Distributed DBMSs

UNIT - II

Distributed Database Design, Distribution Design Issues, Fragmentation, Allocation, Data Directory, Data and Access Control, Query Processing, Objectives of Query Processing, Characterization of Query Processors, Layers of Query Processing, Query Decomposition.

UNIT - III

Transaction Management, Properties, Types of Transactions, Distributed Concurrency Control, Taxonomy of Concurrency Control Mechanisms, Locking-Based Concurrency Control Algorithms, Timestamp-Based Concurrency Control Algorithms, Optimistic Concurrency Control Algorithms.

UNIT - IV

Distributed DBMS Reliability, Reliability Concepts and Measures, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols, Network Partitioning.

UNIT - V

Distributed Object Database Management, Fundamental Object Concepts and Object Models, Object Distribution Design, Architectural Issues, Object Management, Object Query Processing.

TEXT BOOKS

1. Principles of Distributed Database Systems, M. Tamer OZSU and Patrick Valduriez, SpringerIII Edition. 2010.
2. Distributed Databases, Stefano Ceri and Giuseppe Pelagatti, McGraw Hill.

REFERENCE BOOKS

1. Database system concepts', Abraham Silberschatz, Henry Korth, S, Sudarshan, VI Edition, McGraw Hill International.

Course Code	Course Title						Core/Elective
1OE602AD	DEEP LEARNING						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES:

1. Develop and Train Deep Neural Networks.
2. Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection andrecognition.
3. Build and train RNNs, work with NLP and Word Embedding.
4. The internal structure of LSTM and GRU and the differences between them.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Feature Extraction from Image and Video Data.
2. Implement Image Segmentation and Instance Segmentation in Images.
3. Implement image recognition and image classification using a pertained network (TransferLearning).
4. Traffic Information analysis using Twitter Data.
5. Auto encoder for Classification & Feature Extraction.

UNIT - I

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. EarlyNeural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes,Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data.Video Data.

UNIT - II

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. LossFunctions. Data Pre-processing for neural networks, Feature Engineering. Overfitting andUnder fitting. Hyper parameters.

UNIT - III

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neuralnetwork. Input Layers, Convolution Layers. Pooling Layers.

Dense Layers. BackpropagationThrough the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the PoolingLayers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions.Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. TransferLearning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. RCNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT - IV

About NLP & its Toolkits. Language Modeling. Vector Space Model (VSM). Continuous Bag ofWords (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Cooccurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for WordRepresentation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long ShortTerm Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gatedrecurrent unit GRU.

UNIT - V

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy GradientMethods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational.

TEXT BOOKS

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc. 2017
2. Learn Keras for Deep Neural Networks, JojoMoolayil, Apress,2018
3. Deep Learning Projects Using Tensor Flow 2, Vinita Silaparasetty, Apress, 2020.

REFERENCE BOOKS

1. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND, 2017
2. Pro Deep Learning with Tensor Flow, Santanu Pattanayak, Apress, 2017

Course Code	Course Title						Core/Elective
1PC661AD	MACHINE LEARNING LAB						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	-	-	-	2	40	60	1

COURSE OBJECTIVES :

1. Demonstration of different classifiers on different data.
2. Demonstrate ensembling of classifiers for solving real world problems.
3. Make use of real world data to implement machine learning models

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Applymachinelearningalgorithms:datasetpreparation,modelselection, modelbuildingetc.
2. Evaluate various Machine Learning approaches.
3. Use scikit-learn, Kerasand Tensor flow to apply ML techniques.
4. Design and develop solutions to real world problems using ML techniques.
5. Apply unsupervised learning and interpret the results

List of Programs

1. Installation of python environment/Anaconda IDE for machine learning: installing python modules/Packages like scikit-learn, Keras and Tensor flow etc.
2. Programs involving pandas, Numpy and Scipy libraries.
3. Build models using linear regression and logistic regression.
4. Build Models using Decision tree.
5. Build Models using K nearest neighbour.
6. Build Models using Naïve bayes.
7. Build Models using Support vector machine.
8. Demonstrate Clustering using k-means and Interpret the clusters obtained.
9. Demonstrate Clustering using Hierarchicalalgorithms (agglomerative and divisive) and Interprettheclustersobtained.
10. Demonstrate ensemble techniques like boosting, bagging and random forest.
11. Build a classifier, compare its performance with an ensemble technique like random forest.
12. Evaluate various classification algorithms performance on a dataset using various measures like True Positive rate, False positive rate, precision, recalletc.
13. Case study on supervised/unsupervised learning algorithm using Weka tool.

Course Code	Course Title						Core/Elective
1PC662AD	DATA VISUALIZATION LAB						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	-	-	-	2*2	40	60	2

COURSE OBJECTIVES :

1. Learn the basics of data visualization and Tableau Desktop.
2. ToCreate common visualizations such as bar charts, line charts, and pie charts.
3. Create simple calculations in Tableau.
4. Add interactivity to your visualizations with text and visual tooltips.
5. Create more advanced chart types such as maps, scatter plots, and treemaps

COURSE OUTCOMES:

After the completion of course the students will be able to:

1. Understand the basics of data visualization and the best practices for creating effective visualizations.
2. Be able to connect to data sources and create basic visualizations in Tableau Desktop.
3. Be able to create more advanced visualizations and dashboards using table calculations, filters, and actions.
4. Be able to tell data stories using Tableau by creating interactive visualizations and dashboards that communicate insights to an audience.
5. Be familiar with the Tableau ecosystem and be able to find further learning opportunities.

Module - 1 : Introduction to Tableau

- Dataviz best practices
- Getting started with Tableau Desktop
- Connecting to the tutorial dataset
- Creating the first charts
- Filtering and sorting data

Module - 2 : Common charts

- Creating common visualizations (bar charts, line charts etc.)
- Assembling a dashboard layout
- Using dashboard filters

Module - 3 : Transform the data

- Dataviz best practices
- Creating simple calculations in Tableau
- Using table calculations

Module - 4 : Interactions

- Interactivity with text and visual tooltips
- Interactivity with actions (filter, highlight, URL)
- Drilldown between dashboards

Module - 5 : Advanced visualizations

- Dataviz best practices
- Creating more advanced chart types
- Using multiple source tables

Module - 6 : Data Storytelling

- Intro to data storytelling
- Creating a data story in Tableau
- Overview of the Tableau ecosystem
- Further learning opportunities

System Requirements :

- System requirements are listed here under Tableau Desktop and Tableau Prep: https://www.tableau.com/products/techspecs
- The latest version of Tableau Desktop as well as Tableau Prep should be downloaded and installed from here: https://www.tableau.com/tft/activation

TEXTBOOK

1. Visualization Analysis & Design by Tamara Munzner (2014) (ISBN 9781466508910).

REFERENCES BOOKS

1. Interactive Data Visualization for the Web by Scott Murray II Edition (2017)
2. D3.js in Action by Elijah Meeks II Edition (2017).
3. Semiology of Graphics by Jacques Bertin (2010).
4. The Grammar of Graphics by Leland Wilkinson.
5. ggplot2 Elegant Graphics for Data Analysis by Hadley Wickham.

Course Code	Course Title						Core/Elective
1PW663AD	MINI PROJECT						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	-	-	-	2	40	60	1

COURSE OBJECTIVES :

1. To enhance practical and professional skills.
2. To familiarize tools and techniques of systematic literature survey and documentation.
3. To expose students to industry practices and teamwork.
4. To encourage students to work with innovative and entrepreneurial data.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Demonstrate the ability to synthesize and apply knowledge and skills acquired in the academic program to real world problems.
2. Evaluate different solutions based on economic and technical feasibility.
3. Effectively plan a project and confidently perform all aspects of project management.
4. 4. Develop and test the solution.

Guidelines for Mini Project

1. The mini-project is a team activity having maximum of 3 students in a team. This is software based design work.
2. The mini project may be a combination of hardware and software
3. Mini Project should cater to a small system required in laboratory or real life.
4. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.
6. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
7. The student is expected to exert on design, development and testing of the proposed work as per the schedule.
8. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

Course Code	Course Title						Core/Elective
1OE602AD	DEEP LEARNING						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. Develop and Train Deep Neural Networks.
2. Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection andrecognition.
3. Build and train RNNs, work with NLP and Word Embeddings.
4. The internal structure of LSTM and GRU and the differences between them.

COURSE OUTCOMES:

After the completion of course the students will be able to:

1. Feature Extraction from Image and Video Data.
2. Implement Image Segmentation and Instance Segmentation in Images.
3. Implement image recognition and image classification using a pretrained network (TransferLearning).
4. Traffic Information analysis using Twitter Data.
5. Auto encoder for Classification & Feature Extraction.

UNIT - I

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning.Scalars. Vectors. Matrixes,Higher Dimensional Tensors. Manipulating Tensors. Vector Data.Time Series Data.Image Data.VideoData.

UNIT - II

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering.Overfitting and Underfitting. Hyper parameters.

UNIT - III

About CNN. Linear Time Invariant. Image Processing Filtering. Building a

convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. TransferLearning using Inception Oxford VGGModel, Google Inception Model, Microsoft ResNet Model. RCNN, Fast R-CNN, Faster R-CNN,Mask-RCNN,YOLO

UNIT - IV

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Cooccurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Back propagation ThroughTime. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gatedrecurrent unit GRU.

UNIT - V

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding.Variational.

TEXT BOOKS

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017.
2. Learn Keras for Deep Neural Networks, JojoMoolayil, Apress, 2018.
3. Deep Learning Projects Using Tensor Flow2,Vinita Silaparasetty, Apress, 2020.

REFERENCE BOOKS

1. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND, 2017
2. Pro Deep Learning with Tensor Flow, Santanu Pattanayak, Apress, 2017.

Course Code	Course Title						Core/Elective
OE602CE	Green Building Technologies						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To impart knowledge of the principles behind the green building technologies.
2. To know the importance of sustainable use of natural resources and energy.
3. To understand the principles of effective energy and resources management in buildings.
4. To bring awareness of the basic criteria in the green building rating systems.
5. To understand the methodologies to reduce, recycle and reuse towards sustainability.

COURSE OUTCOMES :

After the completion of course the students will be able to:

CO 1. Define a green building, along with its features, benefits and rating systems.

CO 2. Describe the criteriaused forsite selection and water efficiency methods.

CO3. Explain the energy efficiency terms and methods used in green building practices.

CO 4. Select materials for sustainable built environment & adopt waste management methods

CO 5. Describe the methods used to maintain indoor environmental quality.

UNIT - I

Introduction to Green Buildings : D efinition of green buildings and sustainable development, typical features of green buildings, benefits of greenbuildings towards sustainable development. Green building rating systems - GRIHA, IGBC and LEED, overview of the criteria as per the serating systems.

UNIT - II

Site selection and planning : Criteria for site selection, preservation of land scape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting,ventilation, etc.

Water conservation and efficiency : Rainwater harvesting methods for roof & non-roof, reducing landscapewater demand by proper irrigation systems, water efficient plumbing systems, water metering, waste watertreatment,recycleandreusesystems.

UNIT - III

Energy Efficiency : Environmental impact of building constructions, Concepts of embodied energy, operationalenergyandlife cycle energy.

Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials,wind and solar energy harvesting,energy metering and monitoring,conceptof netzerobuildings.

UNIT - IV

Buildingmaterials : Methods to reduce embodied energy in building materials : (a)Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammedearth, stabilizedmud blocks, (c)use of materials with recycled content such as blended cements, pozzolon acements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials.

Waste Management : Handling of construction was tematerials, separation of house hold waste, on-site and off-siteorganic waste management.

UNIT - V

Indoor Environmental Quality for Occupant Comfortand Wellbeing: Daylighting, airventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics.

Codes related to green buildings : NBC, ECBC, ASHRAE, UPC etc.

TEXT BOOKS

1. Michael Bauer, Peter Mösle and Michael Schwarz "Green Building -Guidebook for Sustainable Architecture" Springer, 2010.
2. GRIHAversion 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment

REFERENCE BOOKS

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green. Building Council Publishers.
2. 'Alternative building materials and technologies' by K.S. Jagadish, B.V. Venkatarama Reddy and K.S.Nanjunda Rao.

Course Code	Course Title						Core/Elective
3OE602CS	SOFTWARE ENGINEERING						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
ATD	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. Describe and compare various software development methods and understand the context in which each approach might be applicable.
2. To impart knowledge on variousphases, methodologies and practices of software development.
3. To apply the project management and analysis principles to software project development.
4. To understand the importance of testingin software development, study various testing strategies along with its relationship with software quality and metric
5. To apply the design & testing principles to software project development.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Acquired working knowledge of alternative approaches and techniques for each phase of SDLC.
2. Judge an appropriate process model (s) for software project attributes and analyze requirements for project development.
3. Acquire skills necessary as an independent or as part of a team for architecting a complete software project by identifying solutions for recurring problem sexerting.
4. Concede product quality through testing techniques employing appropriate metrics by understanding the practical challenges associated with the development of a significant software system.
5. Apply the software engineering principles in realtime project development.

UNIT - I

Introduction to Software : What is software? Types of software, Characteristics of Software Attributes of good software.

Software Engineering : What is software engineering, Software engineering costs? What are the key challenges facing software engineering, Systems engineering & software Engineering, SDLC.

Software Development Process Models : prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process.

UNIT - II

Software Engineering Principles : SE Principles, Communication Principles, Planning Principles, Modelling Principles, Construction Principles, Deployment.

Software Requirement Analysis and Specification : System and software requirements, Types of software requirements, Elicitation and analysis of requirements, Requirement validation, Requirements specification, Feasibility.

UNIT - III

Building the Analysis Model : Data Modeling Concepts, Object - Oriented Analysis, Scenario- based Modeling, Flow-oriented Modeling, Class-based Modeling.

Design Engineering : Design Process and Quality, Design Concepts, the Design Model.

Performing User Interface Design : The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT - IV

Creatingan Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design.

Coding: Programming languages and development tools, Selecting languages and tools Good programming practices,Coding Standards.

UNIT - V

Software Testing and Quality Assurance : Verification and validation Techniques of testing Black-box and White-box testing Inspections Levels of testing Unit testing, Integration Testing, Interface testing, System testing, Alpha and beta testing, Regression testing Design of test cases, Quality management activities : Product and process quality Standards, ISO900, Capability Maturity Model (CMM), Risk management.

Debugging : Debugging Techniques, The Art of Debugging.

Currenttrends in Software Engineering: Software Engineering for projects and products.

TEXT BOOKS

1. Roger S.Pressman, Software Engineering : A Practitioner's Approach, VII Edition, McGraw Hill, 2009.
2. Software Engineering by Ian Sommerville, VII edition, Addison - Wesley.
3. Fundamentals of Software Engineering by Rajib Mall.

REFERENCE BOOKS

1. Ali Behforooz and Frederick J. Hudson, Software Engineering Fundamentals, Oxford University Press, 1996.
2. Pankaj Jalote, AnIntegrated Approach to Software Engineering, III Edition, Narosa Publishing House, 2000.

Course Code	Course Title						Core/Elective
5OE602EC	Fundamentals of IOT						Elective
Prerequisite Controllers, Communication protocols, web services	Contact Hoursper Week				CIE	SIE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

COURSE OBJECTIVES:

1. To introduce the fundamentals, applications and requisite infrastructure of IoT.
2. To describe Internet principles and communication technologies relevant to IoT.
3. To discuss hardwareandsoftwareaspectsofdesigninganIoTsystem.
4. To explain the concepts of cloud computing and data analytics.
5. To illustrate the business models and manufacturing strategies of IoT products.

COURSE OUTCOMES:

1. Understand the various applications of IoT and other enabling technologies.
2. Comprehend various protocols and communication technologies used in IoT.
3. Construct simple IoT systems with requisite hardware and p ython programming.
4. Understand the relevance of cloud computing and data analytics to IoT.
5. Apply the business model of IoT from developing a proto type to launching a product.

UNIT - I

Introduction to Internet of Things: Introduction to Internet of Things : Physical Design of IoT : Things in IoT, IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, IoT A pplications : Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and logistics, Smart Agriculture and Industry, Smart Industry and smart Health.

UNIT - II

Internet Principles and communication technology : Internet Communications : An Overview - IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses TCP and UDP Ports, Application Layer Protocols - HTTP, HTTPS,

UNIT - III

Prototyping and Programming : Cost Vs Ease of Production, Prototypes and Production, Open-Source Vs Closed Source. Prototyping Embedded Devices- Sensors, Actuators, Micro controllers, SoC, Choosing a platform, Prototyping Hardware platforms - Arduino, Raspberry Pi. Prototyping the physical design - Laser Cutting, 3Dprinting, CNC Milling.

Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations., Classes, Python packages for IoT, IoT Physical Devices and Endpoints : Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT - IV

Cloud computing and Data analytics : Introduction to Cloud storage models -SAAS, PAAS, IAAS. Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT- Apache Hadoop- Map reduce job execution work flow.

UNIT - V

IoT Case Studies : Case studies illustrating IoT Design – Smart Lighting,Weather Monitoring, Smart Irrigation, Business model for IoT product manufacturing, IoT Startups, Massmanufacturing, Ethical issues in IoT.

TEXT BOOKS :

1. Internet of Things - Converging Technologies for smart environments and integrated ecosystems, River Publishers.
2. Adrian McEwen (Author), Hakim Cassimally, “Designing the Internet of Things”, Wiley India Publishers.

REFERENCEBOOKS:

1. Fundamentals of Python, Kenneth A Lambert and B.L. Juneja, Cenage Learning.
2. Internet of Things (AHands-on-Approach), Vijay Madisetti, Arshdeep Bahga,VPT Publisher, 1stEd., 2014.

OPENELECTIVE - II (VISEM)

Course Code	Course Title	Core/Elective					
4OE602EE	ELECTRIC VEHICLES TECHNOLOGY (OPENELECTIVE–II)	Elective					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

COURSE OBJECTIVES :

The objective of this course is to make the student :

1 Know the history of electric hybrid electric vehicles (EV&HEV) and emphasize the need and importance of EV-HEV for sustainable future.

2 Introduce the fundamental concepts and principles of electric an dhybrid electric vehicles drive train topologies.

3 Developa thorough understanding of the key elements of EV/HEV : Electric Machines for Propulsion Applications and Energy Sources.

COURSE OUTCOMES :

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

1. To identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future.
2. To identify and describe the principles of various EV/HEVs drive train topologies along with the irpower flow control and fuel efficiency estimation.
3. To design and select electric propulsion system components for EV/HEV drives suitability for the desirable performance and control.
4. To compare and evaluate various energy sources and energy storage components for EV and HEV applications.

UNIT - I

Introduction : History of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV, Power / Energy supplies requirements for EV/ HEV applications, vehicle power source characterization, and transmission characteristics. Vehicle mechanics–Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion.

UNIT - II

Drive - Train Topologies : Series, Parallel, Series -Parallel and Complex configurations of HEV, basics of hybrid traction system,various hybrid drive-train to pologies, power flow controlin drive - train topologies, fuel efficiency analysis.

UNIT - III

Electrical Machines and Power Converters for Hybridand Electric Vehicles : Electric system components for EV/HEV, suitability of DC and AC machines for EV/HEV applications, AC and DC Motor drives. Permanent magnet and switch reluctance machines, configuration and control of drives. Power Converters-Converters for EV and HEV applications.

UNIT - IV

Energy Sources for EV/HEV : Requirements of energy supplies and storage in EV/HEV, Review of batteries, fuel cells, fly wheels and ultra-capacitors as energy sources for EV/HEV, characteristics and comparison of energy sources for EV/HEV, hybridization of different energy sources.

UNIT - V

Electric Vehicles Charging Station : Type of Charging station, Selection and Sizing of charging station, Components of chargingStation and Single line diagram of charging station. Contactless inductive charging- Stationary Inductive charging, resonant and compensation circuit topologies.

TEXT BOOKS :

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiely, USA, 2012.
2. Iqbal Hussain, Electric & Hybrid Vehicles - Design Fundamentals, 2nd Edition, CRCPress, 2011.

REFERENCES/SUGGESTEDREADING:

1. Chris Mi, M. Abdul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspective, Wiely, 2011.
2. Simora Onori, Hybrid Electric Vehicles Energy Management Strategies, Springer.

Course Code	Course Title						Core/Elective
6OE602ME	3D PRINTING TECHNOLOGIES						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
NIL	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To understand the fundamental concepts of 3D Printing, its advantages &limitations.
2. To know the various types of STL file errors and other data formats used in additive manufacturing Technology.
3. To know the working principle, advantages, disadvantages & applications of liquid, solid and powder based 3D Printing technologies.
4. To know the diversified applications of 3D Printing technologies and explore them in different industrial sectors.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Describe the fundamentals of 3D printing, classify and explain advantages and disadvantages of 3D Printing technologies.
2. Select thesuitable CAD data formats and software used in 3D Printing technology.
3. Describe the operating principles, capabilities and limitations of liquid, solid & powder based 3D Printing Technologies.
4. Compare different 3D printing technologies based on their process capabilities and applications.
5. Apply the capabilities and knowledge of 3D printing in different industrial sectors.

UNIT - I

Prototyping Fundamentals: Historical Development, Fundamentals of 3D Printing, Advantages and Limitations of 3D Printing, commonly used terms, 3D Printing Process Chain, 3D Modelling, Data conversion and transmission, Checking & Preparing, Building, Post processing, Classification of 3D Printing processes, Fundamental Automated Processes, Distinction between 3D Printing and Conventional Machining Processes.

Data Formats & Software : Data formats; conversion and transmission, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs, Newly Proposed Formats. Software's Features: Magics, Mimics, Solid View, Cura, ITK Snap.

UNIT-II

Liquid based Systems: Stereo Lithography Apparatus (SLA): Models and Specifications, Process, working principle, photopolymers, photo polymerization, Layering Technology, laser and laser scanning, Applications, Advantages and Disadvantages. Poly jet: Models and Specifications, Process, working principle, Applications, Advantages and Disadvantages. **Solid ground curing (SGC):** Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

UNIT - III

Solid-based Systems : Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Fused Deposition.

Modelling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. **Multi Jet Modelling (MJM):** Models and specifications, Process, Working principle, Applications, Advantages and Disadvantages.

UNIT-IV

Powder Based Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. **Three Dimensional Printing (3DP):** Models and Specifications, Process, working principle, Applications, Advantages and Disadvantages. **Laser Engineered Net Shaping (LENS):** Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

UNIT - V

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, Construction field, Arts and Architecture, Pattern for investment and vacuum casting, Medical Models and Bioengineering Applications: Planning and simulation of complex surgery,

Customized Implants & Prosthesis, Design and Production Medical Devices, Forensic Science and Anthropology and Web Based Rapid Prototyping Systems.

TEXT BOOKS :

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific
2. 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" Springer, Second Edition.

REFERENCE BOOKS :

1. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies:
2. Frank W. Liou, "Rapid Prototyping & Engineering Applications" - CRC Press, Taylor & Francis Group.
3. Rafiq Noorani, "Rapid Prototyping : Principles and Applications in Manufacturing", John Wiley & Sons.