Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
	ED	Advance Topics in Data Processing	3	1	0	4	25	25	50	-	-	

COURSE OUTCOMES

1. Understand the implementation procedures for the data science algorithms.
2. Recognize classes of optimization problems in data science and related disciplines.
3. Understand the features of largescale datasets to apply to real-world problems
4. Understand the fundamental concepts of the evolutionary algorithms
5. Ability to apply the data science algorithms on various real-life problems.

COURSE CONTENTS

UNIT-1

Time Series Analysis: Modeling time series data, Time Series data Manipulation, Moving Averages and Exponential Smoothing, Stationarity and Seasonality, Determining Stationarity, Autoregression to the rescue, Auto regressive models.

UNIT-2

Text and Natural Language Processing: Web Mining, Page Rank Algorithms, Matching Regular Expression, Processing text with Unicode, Tokenizing text, Word Tagging, Topic Modelling, Latent Dirichlet Allocation, LDA in action

UNIT-3

Graph Theory and Social Network Analysis: Socializing, Basics of Graphs and Networks, Centrality measures, degree, network properties, NetworkX, Conflict and fission in network. Case Study: Karate kids data.

UNIT-4

Neural Networks and Deep Learning: Stochastic gradient method**,** Dual averaging, Polyak–Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems.

UNIT-5

Machine Learning Deployment, Cover, Model Deployment and Challenges, Machine Learning Deployment as a Web Service, Deployment Using Docker, Deployment Using Kubernetes

SUGGESTED READINGS

- "Data Mining and Analysis: Fundamental Concepts and Algorithms", Mohammed J. Zaki, Wagner Meira, Jr, Wagner Meira,2014.
- "Deploy Machine Learning Models to Production: With Flask, Streamlit, Docker, and Kubernetes on Google Cloud Platform", Pramod Singh, 2020
- "Advanced Data Science and Analytics with Python", Jesus Rogel-Salazar ,2020

Syllabus for ED Courses of CSE Department

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites

COCSE57, CACSE53	**ED**	**AUGMENTED REALITY**	**3**	**0**	**2**	**4**	**15**	**15**	**40**	**15**	**15**	**Computer vision,**

COURSE OUTCOMES

1. . Describe how AR systems work and list the applications of AR.
2. . Understand and analyses the hardware requirement of AR..
3. . Use computer vision concepts for AR and describe AR techniques.
4. . Analyze and understand the working of various state of the art AR devices.
5. Acquire knowledge of mixed reality.

COURSE CONTENTS

UNIT-1 Introduction to Augmented Reality (A.R)

What Is Augmented Reality - Defining augmented reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, **applications of augmented reality Augmented Reality Concepts**- How Does Augmented Reality Work? Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.

UNIT-2 Augmented Reality Hardware

Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, **Processor Specifications. Tracking & Sensors** - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.
.

UNIT-3 Computer Vision for Augmented Reality & A.R. Software
Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and **Mapping, Outdoor Tracking Augmented Reality** Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.

UNIT-4AR Techniques- Marker based & Markerless tracking

Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of **matrix multiplication Marker types**- Template markers, 2D barcode markers, imperceptible markers. Marker-less approach- Localization based augmentation, real **world examples Tracking methods**- Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery

UNIT-5 AR Devices & Components

AR Components – Scene Generator, Tracking system, monitoring system, display, Game **scene AR Devices** – Optical See- Through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, Video see-through systems

List of practical (for 302 LTP only):

- .

SUGGESTED READINGS

- Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978-1484236178

- . Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
- Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
- Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	Pre-requisites
		Current Trends in Software Development	3	1	0	4	25	25	50	Software Engineering, and Object Oriented Concepts

COURSE OUTCOMES

- Acquire knowledge on the wider perspective of software engineering and architecture issues
- Implement the mathematical notation of the software systems through formal methods.
- Design and construct the software systems using reusable software "components" by acquiring the knowledge about domain engineering and component based development
- Merge the conventional principles, concepts and methods in software engineering with the elements of object oriented and CBSE to create client/server systems.
- Create high quality web applications by using software engineering concepts and principles like formulation, planning, analysis testing and evaluation.

COURSE CONTENTS:

UNIT I

Basic concepts, mathematical preliminaries, applying mathematical notations for formal specification, formal specification languages, using Z to represent an example software component, the ten commandments of formal methods

UNIT II

Approach, functional specification, design and testing. Component-Based Software Engineering: CBSE process, domain engineering, component-based development, classifying and retrieving components, and economics of CBSE. Client/Server Software Engineering: Structure of client/server systems, software engineering for Client/Server systems, analysis modelling issues, design and testing issues.

UNIT III

Attributes of web-based applications, the WebE process, a framework for WebE, formulating, analysing web-based systems, design and testing for web-based applications, Management issues.

Business process reengineering, software reengineering, reverse reengineering, restructuring, forward reengineering, Economics of reengineering. Building blocks and taxonomy for CASE, integrated CASE environments, integration architecture, CASE repository, case Study of tools like

TCS Robot.

UNIT IV

Model View Controller, Presentation Abstraction Control, UML based development, Use cases, Testing: Mobile infrastructure, Validating use cases, Effect of dimensions of mobility on testing, Case study: IT company, design, Implementation.

UNIT V

Characteristics, I/O, Embedded systems/real time systems. Embedded software architecture, control loop, interrupts control system, co-operating multitasking, pre-emptive multitasking, Domain analysis, Software element analysis, requirement analysis, Specification, Software architecture, Software analysis design, implementation, testing, validation, verification and debugging of embedded systems

SUGGESTED READINGS:

- Software Engineering a Practitioners Approach, Roger S. Pressman, McGraw-Hill, 8 th Edition(2014)
- Formal Specification and Documentation using Z - A Case Study Approach, J.Bowan, International Thomson Computer Press (2003)
- Software Engineering for Embedded Systems: Methods, Practical Techniques, and Applications, Robert Oshana, Mark Kraeling, Newnes Publisher (2013)

Course No.	Type	Subject	L	T	P	Credits	TCA	TMS	TES	Pre-requisites
COCSE59, CACSE55	**ED**	**Human Computer Interface**	**3**	**1**	**0**	**4**	**25**	**25**	**50**	Computer Architecture, Computer Graphics

COURSE OUTCOMES

1. To be able to understand the importance of designing interactive products those are usable.
2. To be able to communicate effectively about requirements, design, and evaluation activities related to interactive products.
3. To be able to evaluate an interactive product using suitable techniques.
4. To be able to incorporate the convenient user interfaces in different devices.
5. To be able to understand the emerging technology in hardware and their usages

COURSE CONTENTS

UNIT-1

Importance of user Interface – definition, importance of good design. Benefits of good design.
A brief history of Screen design.

The graphical user interface – popularity of graphics, the concept of direct manipulation,

graphical system, characteristics, Web user – Interface popularity, characteristics- Principles of user interface.

UNIT-2

Design process – Human interaction with computers, importance of human characteristics human consideration, human interaction speeds, understanding business junctions.

UNIT-3

Screen Designing : Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.

UNIT-4

Windows – New and Navigation schemes selection of window, selection of devices based and screen based controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.

UNIT-5

Software tools – Specification methods, interface – Building Tools. Interaction Devices – Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers. Guidelines for project based work: Semester long projects/presentations/ research work/ term papers based on the above topics.

SUGGESTED READINGS

- Galitz, W. O. 2007. The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques. 3rd Edition, Wiley.
- Dix, A. Finlay, J., Abowd, G. and Beale, R. 2004. Human-Computer Interaction, 3rd Edition, Prentice Hall.
- Preece, J., Sharp, H. and Rogers, Y. 2015. Interaction Design: Beyond HumanComputer Interaction, 4th Edition, Wiley.
- Shneiderman, B., Plaisant, C., Cohen, M. S., Jacobs, S., Elmqvist, N., & Diakopoulos, N. 2016. *Designing the user interface: strategies for effective human-computer interaction*. Pearson.
- MacKenzie, I. S., & Tanaka-Ishii, K. 2010. *Text entry systems: Mobility, accessibility, universality*. Elsevier.

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
	ED	**Information Retrieval**	**3**	**1**	**0**	**4**	**25**	**25**	**50**	**-**	**-**	

COURSE OUTCOMES

1. Understand the implementation procedures for the Information retrieval.
2. Recognize algorithms and methods for information retrieval.
3. Understand the features of largescale datasets to apply to real-world problems
4. Understand the fundamental concepts of information retrieval in Web
5. Ability to apply the information retrieval methods to real world domains.

COURSE CONTENTS

UNIT-1

Introduction to Information Retrieval: Boolean retrieval, Vocabulary & postings lists, Dictionaries and tolerant retrieval

Index Construction: Single pass in-memory indexing, Distributed indexing, dynamic indexing, Index Compression.

UNIT-2

Scoring, Term weighting & the vector space model, Computing scores in a complete search system, Evaluation in information retrieval

Relevance feedback & query expansion: Rocchio algorithm, Probabilistic relevance feedback, Pseudo relevance feedback

UNIT-3

XML retrieval, Probabilistic information retrieval, Language models for information retrieval

Text classification & Naive Bayes, Vector space classification, Support vector machines & machine learning on documents, Document zones in text classification, feature space of document zones

UNIT-4

Clustering techniques: Cardinality of cluster, Model-Based clustering, Document Clustering, Flat clustering, Hierarchical clustering

Matrix decompositions & latent semantic indexing

UNIT-5

Web data Retrieval: Web search basics, PageRank Algorithm, Personalized PageRank, Web crawling and indexes, Link analysis

SUGGESTED READINGS

- "Introduction to information retrieval" Christopher D. Manning, Hinrich Schütze, and Prabhakar RaghavanKulkarni, 2008
- " Modern Information Rrtrieval", Ricardo Baeza, Berthier Riberia, fourth edition, 2009

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
CACSE51	**ED**	**Intelligent Computing**	**3**	**1**	**0**	**4**	**25**	**25**	**50**			

COURSE OUTCOMES

1. Identify the difference between different branches of AI.
2. Analyze a fuzzy based system.
3. Design Neural Networks to solve problems.
4. Understand the various concepts, terminologies, and architecture of IoT systems.
5. Identify the components of a cloud-based system.

COURSE CONTENTS

UNIT-1

Introduction

Defining concepts of Computing, Conventional Computing vs. Intelligent Computing, Applications and Need of Intelligent Computing, Current trends in Intelligent Computing

UNIT-2

Soft Computing Concepts:
Hard Computing vs. Soft Computing, Paradigms of Soft Computing, Soft Computing Constituents, Real Life applications of Soft Computing

Fuzzy Logic:
Classical Sets Vs Fuzzy Sets, Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Fuzzy Composition (Max-Min, Max-Product), Defuzzification, Fuzzy Inference System

Evolutionary Computation:
Principle of Optimization, Traditional vs Evolutionary optimization, Search Operators and Representations Genetic Algorithm: Genetic Programming, Multi-objective Evolutionary Optimization: Pareto optimality, multi-objective evolutionary algorithms.

UNIT-3

AI Concepts:
Introduction to AI, AI problems and Solution approaches, Fundamentals of problem-solving using Search and Heuristics, Foundations for AI: Application areas, AI Basics (Divide and Conquer, Greedy, Branch and Bound, Gradient Descent), NN basics (Perceptron and MLP, FFN, Backpropagation), Use Cases in Business and Scope: Credit card Fraud Analysis, Recommendation Systems and Collaborative filtering, Sales Funnel Analysis, etc.

UNIT-4

Cloud Computing:
Conventional Computing, Historical developments, Cloud Computing reference model, Cloud Architecture- Layers and Models
Overview of Virtualization: Introduction, Types of cloud, Cloud Platforms: Amazon Web Services, Microsoft Azure, Cloud Applications

UNIT-5

IoT Concepts:
The IoT Paradigm, Concept of Things, IoT Hardware, IoT Protocols, IoT Architecture, enabling technologies of IoT, IoT Designing and its levels.

SUGGESTED READINGS

- Rich Elaine, Knight Kevin, Nair S. B. Artificial Intelligence, 3rd Edition, Tata Mc. Graw Hill.
- Padhy N. P., Simon S. P. Soft Computing: With MATLAB Programming, Oxford University Press, 2015.
- Buyya Raj Kumar, Vecchiola Christian &Selvi S. Thamarai , Mastering Cloud Computing, McGraw Hill Publication, New Delhi, 2013.
- Madisetti Vijay and BahgaArshdeep, Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2014.
- Fuzzy Logic with Engineering Applications, Timothy J. Ross, McGraw-Hill, 1997.

- Shivanandam and Deepa, Principles of Soft Computing, 2nd Edition, John Wiley and Sons, 2011.

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
		IOT for Artificial Intelligence				4	25	25	50	-	-	Statistics, Probability Distributions, Sample Theory; Linear Algebra, Python

COURSE OUTCOMES

- Explore and learn fundamentals of Internet of Things with the help of preparing projects designed for Arduino and Raspberry Pi.
- To understand the power of AI driven IoT in business applications.
- To understand IoT Basic Operation using Machine Learning Algorithms.
- To understand basics of Communication & Design Aspects in IOT
- To understand the role of the Internet of Things (IoT) for development and creating a smart world that facilitates sustainable economic development along with a high quality of life.

COURSE CONTENTS:

UNIT I

Introduction: Understanding IoT fundamentals, IOT Architecture and protocols, Characteristics of IoT data in the real world, Various Platforms for IoT, Real-time Examples of IoT, Overview of IoT components and IoT Communication Technologies, Challenges in IoT.
Arduino Simulation Environment: Arduino Uno Architecture, Setup the IDE, Arduino Libraries, Basics of Embedded C programming for Arduino, Interfacing LED, Sensors, Actuators, Push-button and Buzzer with Arduino.
Raspberry Simulation Environment : Introduction to Raspberry Pi, Installation, Setup and Configuration.

UNIT II: Artificial Intelligence of Things (AIOT): IoT Vs AI, Drivers of IoT growth enabled by AI, Fundamentals of types of computing in the world of AIoT : Fog computing, Dew computing, Cloud computing, Edge computing, How AIoT solution works ,Benefits of AI Enabled IoT, Examples of Exercising IoT using AI in the Real World, IoT Platforms with AI capabilities.

UNIT III: Machine Learning for IoT: IoT Basic Operation using Machine Learning- Node Localization, Clustering, Routing, Data Aggregation, Taxonomy of machine learning algorithms that can be adopted in IoT- Classification, Clustering, Anomaly Detection, SVM, K-Nearest Neighbors, K-Means, Naïve Bayes, Principal Component Analysis.

UNIT IV

Communication & Design Aspects in IOT: LoRa Wireless for IoT, 5G and IoT, Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination IoT Radio Frequency Identification. IoT Requirements & Challenges, IoT Services and Applications, IoT Sensors & Antennas, Cloud Computing and IoT, IoT Protocol Stacks, IoT Security aspects, NB-GSM For IoT.

UNIT V

Case Studies: Smart City, Smart Energy, Smart Agriculture System, Face Recognition Bot, Smart Alarm Clock, Air Pollution Monitoring System.

SUGGESTED READINGS

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547

2. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.

3. Ad HOC Wireless Networks: Architectures & Protocols by C Siva Ram Murty & BS Manoj 2nd Ed, Pearson

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	Pre-requisites
COCSE53	**ED**	IT Infrastructure and Management	3	1	0	4	25	25	50	Computer Networks, Software Engineering

COURSE OUTCOMES

- Identify, evaluate and select an integrated IT infrastructure (hardware, software, architectures, and services) to best fulfill a given set of organizational requirements.
- Critically analyze an existing IT infrastructure, identify its strengths and weaknesses, and develop a roadmap for future evolution.
- Critically assess an emerging technology and demonstrate how it can be used to enhance a firm's competitive position.
- Analyze and appraise the technical, managerial, security, regulatory, and ethical issues associated with the acquisition, deployment, and management of modern IT infrastructures and emerging technologies.

COURSE CONTENTS:

UNIT I

Introduction To Infrastructure: Introduction to IT Building Blocks, Infrastructure, Nonfunctional Attributes, Calculating Availability, Availability Percentages, and Intervals, Mean Time Between Failures (MTBR), Mean Time to Repair (MTTR), Sources of Unavailability, Availability Patters, Introduction to Performance: Performance During Infrastructure Design, Performance of a Running System, Performance Patterns.

UNIT II

Networking: TCP/IP protocol suite and Architecture, LAN/MAN, Hierarchal LAN Design, Multiservice Access Technologies, Wi-Fi protocols, Business use of Mobile/Ubiquitous computing, Virtual Private Networks, Implementing and securing IP addressing services for the WAN.

Storage Building Blocks, DAS, NAS, SAN, Software Defined Storage, Storage Availability, Storage Performance, Storage Area Networks, Fiber channel: Protocol, topologies, addressing, SAN benefits, Storage virtualization, Storage Security.

UNIT III

Cloud layers, Cloud deployment models, Introduction, Compute Building Blocks, Memory, Interfaces, Compute Virtualization -Container Technology, Mainframes, Midrange Systems, X86 Servers, Supercomputers, Compute Availability, Compute Performance, Compute Security, Popular Operating Systems, Operating System Availability, Operating System Performance, Operating System Security.

UNIT IV

Datacenters, Introduction, Designs, Technical and Economic considerations, Strategic IT infrastructure investment, TCO of Data Center, Server technologies and architectures, Server Virtualization: Value proposition and Technical Challenges, Green Computing: Approaches and regulations.

Web 2.0, Towards Web 3.0 ad Semantic Web, Web Service Standards

UNIT V

Infrastructure Security, Risk Management, Risk Response, Exploits, Security Controls, Attack Vectors, Identity and Access Management, Segregation of Duties and Least Privilege -Layered Security, Cryptography, Monitoring, Vulnerability Patching, Go Live Process/Checklist, Decommissioning a Service/Device.

RFID Technology: Architecture and protocols, applications, problems with RFID

SUGGESTED READINGS:

- SJaak Laan, "IT Infrastructure Architecture – Infrastructure Building Blocks and Concepts", Third Edition, Lulu Press Inc, 2017.
- Thomas Erl, Zaigham Mahmood, Ricardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Prentice Hall, 2013.

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
COCSE58,	**ED**	**Knowledge Based System**	**3**	**0**	**2**	**4**	**15**	**15**	**40**	**15**	**15**	

CACSE54												

COURSE OUTCOMES

- Develop a general understanding of A. I. concepts and KBS and use the various search mechanisms to solve a problem.
- Understand knowledge acquisition techniques and use knowledge representation methods.
- Use inference techniques to improve prediction and decision support.
- Apply artificial intelligence methods such as fuzzy learning, Bayes' method etc., to handle uncertainty.

COURSE CONTENTS

UNIT-1

Introduction to Intelligence and Artificial Intelligence, Overview of Artificial Intelligence, History of Artificial Intelligence, Characteristics of AI Programs, Symbolic processing, Knowledge Representation, Search, Heuristics, Applications of Artificial Intelligence
Search: Process of Searching, Representing search problems, Search strategies, Uninformed (blind) search, Informed (heuristic) search

UNIT-2
Introduction to Knowledge Based System: Data, Information and knowledge, Types of knowledge, Types of knowledge based systems. **Knowledge Representation**: Definition, Knowledge representations schemes, Logic Representation, Prepositional logic, Predicate logic, Logic Programming, Introduction to PROLOG, Semantic networks, Frames

UNIT-3
Productions and Rule based systems: Architecture of a Production System, Execution in a Production System, Comparison of the Various Knowledge Schemes
Knowledge Acquisition: Sources of Knowledge, Categories of Knowledge Acquisition Methods, Top-Down Methods and Bottom-Up Methods, Knowledge Acquisition Modes
Base techniques of knowledge-based systems: rule-based techniques, inductive techniques, hybrid techniques, symbol-manipulation techniques, case-based techniques

UNIT-4
Expert Systems: Definition, Structure of An Expert System, A methodology for the development of expert system, Expert System Shells, Case-based reasoning (CBR), Case, Case – indexing
Main components of case-based systems
Inference: Definition, Inference Strategies in Artificial Intelligence Applications
Rule-based inference controls: Forward chaining, Backward chaining

UNIT-5
Knowledge Based Systems Software Lifecycles: Software Life Cycles, Characteristics of KBS Projects, Commonalities in KBS, The Waterfall Model, KADS Methodology
Uncertainty: AI classification of uncertainty, Handling Uncertainty, Confidence/Certainty Factors, Bayes' Theorem

SUGGESTED READINGS

- Gonzalez, A. J. and Dankel, D. D. The Engineering of Knowledge-based Systems. Prentice Hall, 1993. ISBN-10: 0132769409, ISBN-13: 978-0132769402.
- Durkin, J., Expert Systems: Design and Development. Prentice Hall, New York, NY, 1994. ISBN-10: 0023309709, ISBN-13: 978-0023309700.
- Russell, S. and Norvig, P. Artificial Intelligence: A Modern Approach. Third edition. Prentice Hall. 2010. ISBN-10: 0136042597, ISBN-13: 978-0136042594.
- Puppe, F. Systematic Introduction to Expert Systems: Knowledge Representations and

Problem-Solving Methods. Springer. 2011. ISBN-10: 3642779735, ISBN-13: 978-3642779732.
- Mitchell, T. Machine Learning. McGraw-Hill. 1997. ISBN-10: 0070428077, ISBN-13: 978-0070428072.
- Witten, I. H., Frank, E., and Hall, M. A. Data Mining: Practical Machine Learning Tools and Techniques. Third edition. 2011. ISBN-10: 0123748569 | ISBN-13: 978-0123748560

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
	ED	**Large Scale Optimization for Data Science**	**3**	**1**	**0**	**4**	**25**	**25**	**50**	**-**	**-**	

COURSE OUTCOMES

1. Understand the implementation procedures for the data science algorithms.
2. Recognize classes of optimization problems in data science and related disciplines.
3. Understand the features of largescale datasets to apply to real-world problems
4. Understand the fundamental concepts of the evolutionary algorithms
5. Ability to apply the theory of optimization methods and algorithms to solve various types of optimization problems

COURSE CONTENTS

UNIT-1

Introduction to Optimization: Engineering application of Optimization, Statement of an Optimization problem, Optimal Problem formulation, Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima, Optimality criteria, Review of basic calculus concepts, Global optimality.

UNIT-2

Unconstrained non-linear optimization Theory, Linear and nonlinear regression, logistic regression, Numerical Solution of linear systems, One-dimensional search algorithms

Gradient-based methods: Gradient descent, sub-gradient, mirror descent, Frank–Wolfe method, Nesterov's accelerated gradient method, ODE interpretations, dual methods, Nesterov's smoothing, proximal gradient methods

UNIT-3

Convex optimization: convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP), convex relaxation, duality.

Operator splitting methods: Augmented Lagrangian methods, alternating direction method of multipliers (ADMM), monotone operators, Douglas–Rachford splitting, primal and dual decomposition

UNIT-4

Stochastic and nonconvex optimization: Stochastic gradient method**,** Dual averaging, Polyak–Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems.

UNIT-5

Modern methods of Optimization: Evolutionary algorithms, Genetic Algorithms, Swarm Intelligence methods, Particle swarm optimization method, Grey Wolf Optimizer, Applications**.**
Real world applications of Image/Video/Multimedia Processing

SUGGESTED READINGS

- Stephen Boyd and Lieven Vandenberghe's book: Convex Optimization
- Nesterov's new book: Lectures on Convex Optimization
- Introduction to Nonlinear Optimization - Theory, Algorithms and Applications by Amir Beck
- K. Deb, 'Optimization for Engineering Design Algorithms and Examples', PHI, 2000
- Kulkarni, A. J., & Satapathy, S. C. (Eds.). (2020). Optimization in machine learning and applications (pp. 51-68). Heidelberg: Springer.
- Sra, S., Nowozin, S., & Wright, S. J. (Eds.). (2012). Optimization for machine learning. Mit Press.
- Jain, P., & Kar, P. (2017). Non-convex optimization for machine learning. Foundations and Trends® in Machine Learning, 10(3-4), 142-363.

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
COCSE61	**ED**	Mobile and IoT Devices Analytic	**3**	**0**	**2**	**4**	**15**	**15**	**40**	**15**	**15**	

COURSE OUTCOMES

- . Understand IoT architecture and edge computing.
- Analyses data using various statistical tools and experiment based on R and Python languages.
- Apply data visualization techniques and implementing an interactive application dashboard.
- Deploy a data analytic technique over real time IoT application.

COURSE CONTENTS

UNIT I

Introduction to IoT: context setting, what is IoT – In depth explanation, IoT applications in different domains and verticals, IoT market in different domains, Introduction to IoT Architecture and Technologies: Architecture, tech stack, Hardware and Software Platform, Communication protocols, Cloud and IoT, Analytics & Visualization and IoT, IoT security, Fog Computing: A platform for Internet of Things and Analytics: a massively distributed number of sources – Big Data Metadata Management in smart grids, semantic inconsistencies: role of metadata

UNIT II

Introduction to Mobile Analytics, the mobile market, mobile technology: growth and reach, mobile platform and applications, mobile apps market, impact of mobile-mobility, enterprise mobility-bring your own device, business context; mobile commerce, mobile payment, mobile wallets, threats to mobile data, machine to machine in healthcare and automobiles.

UNIT III

File operation: read and write to a CSV/Excel file, connect to a big data source and extract data using R, data exploration cleans up and transformation with R, describe and summarize data using functions in R, introduction to geomaps for plotting on a geographical map, use raster for plotting fraudulent claims by categories.

UNIT IV

Statistical Analysis: techniques for visualizing relationship in data and understanding the relationships, exploring data-visualization correlation and regression, probability distribution, introduction to Azure ML platform.

UNIT V

Machine learning-concept of machine learning, Regression-linear and non-linear, Algorithms-MLR, Logistics regression, classification algorithms- SVM, decision trees and boosted decision trees, Naïve bayes; Quality of classification- concepts of ROC, hit rate, kappa statistics and K-S statistics, marketing analytics-conjoint analysis, hidden markov models.

SUGGESTED READINGS

- Arshdeep Bahga and Vijay Madisetti, Internet of Things - A Hands-on Approach (1 ed.), Universities Press, 2015. ISBN 978-8173719547.
- Garrett Grolemund, Hands on Programming with R (1 ed.), O′Reilly, 2014. ISBN 978-1449359010.
- Michael J Crawley and john, The R Book (2 ed.), Wiley & Sons, 2012. ISBN 978 0470973929.
- Hadley Wickham and Garrett Grolemund, R for Data Science (1 ed.), O'Reilly, 2016. ISBN 978-1491910382.
- Amir M. Rahmani, Pasi Liljeberg, Jürgo-Sören Preden and Axel Jantsch, Fog Computing on the Internet of Things (1 ed.), Springer International Publishing, 2018. ISBN 978-3319862149.

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
COCSE62	**ED**	**Multimedia Security and Forensics**	**3**	**1**	**0**	**4**	**25**	**25**	**50**			**None**

COURSE OUTCOMES

1. Demonstrate a systematic understanding of multimedia computing and main security problems involving multimedia data and/or devices
2. Understand how different types of digital watermarking and steganographic systems work for different applications
3. Implement simple multimedia security algorithms and conduct performance analysis
4. Understand differences and linkages between multimedia security and digital forensics
5. Understand basic concepts, procedures, applications and main techniques behind digital forensics tools.

COURSE CONTENTS

UNIT-1: Fundamentals of Multimedia Computing: Multimedia systems, devices and data, General multimedia security concepts, Multimedia coding, Color space and human visual system (VHS), Lossless and lossy data compression for multimedia data.

UNIT-2: Steganography and Steganalysis: What is steganography (cryptography vs. steganography), Classifications of steganography, Main properties of steganographic systems, Selected steganographic schemes (e.g., LSB steganography), General concepts of steganalysis, Selected steganalytic methods.

UNIT-3: Digital Watermarking: What is digital watermarking (steganography vs. digital watermarking), Applications of digital watermarking, Main properties and classifications of digital watermarking systems, Modelling of digital watermarking systems.

UNIT-4: Digital Watermarking Algorithms: Selected digital watermarking algorithms (e.g. LSB based approach and those in DCT domain), Security of digital watermarking systems

UNIT-5: Digital Forensics: Digital evidence handling procedures (collection, processing and preservation), Device forensics (computer forensics, mobile forensics), Memory forensics, Network forensics, multimedia forensics, anti-forensics, Forensic report writing and expert testimony, Standards and best practices in digital forensics, How law enforcement agencies and industry use digital forensics tools

SUGGESTED READINGS

- https://link.springer.com/book/10.1007/978-1-59745-577-0
- https://www.wiley.com/enus/Handbook+of+Digital+Forensics+of+Multimedia+Data+ and+Devices-p-9781118640500
- https://catalogue.surrey.ac.uk/2022-3/module/COMM046
- https://www.indiamart.com/proddetail/handbook-of-digital-forensics-of-multimedia-data-and-devices-19337841333.html

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
CACSE58	**ED**	**Multimodal AI**	**3**	**0**	**2**	**4**	**15**	**15**	**40**	**15**	**15**	

COURSE OUTCOMES

1. Understand the recent technical achievements in multimodal research.
2. Apply critical and creative thinking skills for multimodal AI.
3. Identify the future research challenges in multimodal Artificial Intelligence.
4. Deploy new research ideas in multimodal learning for real time use cases.

COURSE CONTENTS

UNIT-1

Introduction, Multimodal applications and datasets, Basic concepts: neural networks, Loss functions and neural networks, Basic concepts: network optimization, Gradients and backpropagation, Visual unimodal representations, Language unimodal representation, Multimodal representation learning,

Coordinated representations, Multimodal alignment, Alignment and representation, Alignment and translation.

UNIT-2

Introduction to Computer Vision: Object recognition, semantic segmentation, face recognition, gender/age recognition, OCR (optical character recognition), image search/retrieval, predictive analytics based on image

UNIT-3

Introduction to Natural Language processing: Tokenization, POS tagging, keyword extraction, synonym/antonym detection, information extraction, relation extraction, semantic search, natural language understanding Speech Recognition Technologies: Language model extraction from Web text, acoustic model creation, hot word/trigger word detection, noise cancellation, etc

UNIT-4

Probabilistic graphical models, Dynamic Bayesian networks, Coupled and factor HMMs, Discriminative graphical models, Continuous and fully-connected CRFs, Deep Generative Models, Variational auto-encoder, Generative adversarial networks, Reinforcement learning, Markov decision process, Q learning and Deep Q learning, Multimodal RL, Policy gradients, Multimodal applications, Fusion and co-learning, Multi-kernel learning and fusion, Few shot learning and co-learning

UNIT-5

Case Studies for various applications: Face Recognition, Counting and Statistics Platform, Speech Recognition and Synthesis, Optical Character Recognition, Predictive analytics.

SUGGESTED READINGS

- Deep Learning, Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press, 2016 (freely available at http://www.deeplearningbook.org)
- The Handbook of Multimodal-Multisensor Interfaces, Sharon Oviatt, Bjoern Schuller, Philip R. Cohen, Daniel Sonntag, Gerasimos Potamianos and Antonio Kruger, Volumes 1, 2 and 3, 2017- 2019 (available through CMU Library online)
- Machine Learning for Audio, Image and Video Analysis: Theory and Applications, Francesco Camastra and Alessandro Vinciarelli, Springer, 2008, DOI: 10.1007/978-1-84800-007-0 (freely available on SpringerLink for CMU students)
- Multimodal Processing and Interaction, Gros, Potamianos and Maragos, SpringerLink, 2008, DOI: 10.1007/978-0-387-76316-3 (freely available on SpringerLink for CMU students)
- Multimodal Signal Processing: Theory and applications for human-computer interaction by Jean-Philippe Thiran, Ferran Marqués and Hervé Bourlard. Academic Press, ISBN: 978-0-12-374825-6

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
COCSE54	ED	Object Oriented Analysis and Design with Unified Process	**3**	**0**	**2**	**4**	**15**	**15**	**40**	**15**	**15**	Software Engineering

COURSE OUTCOMES

1. To learn Basic concepts of OO analysis and Rational Unified Process
2. To model the functional view of problem domain using Use case Diagram and Activity diagram
3. To model the static and behavioral view of Problem domain using UML
4. To learn Different techniques for Cost and Effort Estimation for OO System, OO testing ,OO metrics and Design patterns

COURSE CONTENTS

Unit 1:

Difference between structured and Object Oriented Analysis, Introduction to object oriented analysis, Different views of modeling, Introduction to different OO Analysis techniques, Introduction to Unified Modeling language, Conceptual Model of Unified Modeling Language (UML)

Introduction to Rational Unified Process: Process Overview- Two dimensions, Phases and iteration on Time dimension, static structure of the process, Core Workflows

Unit 2

Introduction to Use Case Diagram concepts. Types of relationships in Use Case Diagram, Use Case Narrative, Activity diagram Essentials- Activities and Actions, Decisions and Merges, Forks and Joins, Time Events, Calling other activities, Objects Sending and receiving Signals, Swim lanes, Pins, Managing Complex activity diagrams- Connectors, Expansion regions

Unit 3

Class Diagram : What is a Class, Abstraction, Encapsulation, Visibility, Notation for Operations and Attributes, Class Relationships, Abstract Classes, Interfaces, Templates, Introduction to Object Diagram,

Sequence Diagram : Events, Signals and different types of Messages, Activation Bars, Sequence Fragments, Use case and Sequence Diagrams, Communication Diagram

State Machine Diagram in detail

Unit 4

Timing Diagram, Composite Structure diagram, Package Diagram, Interaction Overview diagram, Component Diagram, Deployment Diagram, Introduction to Object Constraint Language

Unit 5

Effort Estimation for OO sytems using Use case diagram, Intoduction to Object Oriented Metrics, Introduction to Object Oriented testing, Introduction to Design Patterns

Practical:

- Choose a problem domain and textually write the Functional and Non Functional requirements of the domain. While writing make use of elicitation techniques
- For the Problem domain in Practical one develop a Use case diagram
- Draw the Activity diagram for the problem domain
- Draw the Sequence diagram and Communication diagram corresponding to Use case daigram
- Draw the Dynamic view of working of an ATM Machine or Microwave Oven using State machine Diagram
- Identify the Clasess and identify their attributes and operations and draw the class diagram
- Implement the working system for the class diagram obtained

- Perform the effort estimation using the Use case diagram for your problem domain

SUGGESTED READINGS

- Object Oriented Modeling and Design with UML by Michael R Blaha and James R Rumbaugh, 2nd Edition, Pearson
- Learning UML 2.0 by Russ Miles and Kim Hamilton, Oreilly 2012
- UML distilled, Third Edition by Martin Fowler, Addison Wesley .
- The Unified Software Development Process by I*var* Jacobson, Booch and Rumbaugh,Addison Wesley, 2007

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
CACSE50,	**ED**	**Optimization Technique for machine learning**	**3**	**1**	**0**	**4**	**25**	**25**	**50**	**-**	**-**	

COURSE OUTCOMES

1. Understand the implementation procedures for the machine learning algorithms.
2. Recognize classes of optimization problems in machine learning and related disciplines.
3. Understand the features of machine learning to apply to real-world problems
4. Understand the fundamental concepts of the evolutionary algorithms
5. Ability to apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems

COURSE CONTENTS

UNIT-1

Introduction to Optimization: Engineering application of Optimization, Statement of an Optimization problem, Optimal Problem formulation, Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima, Optimality criteria, Review of basic calculus concepts, Global optimality.

UNIT-2

Convex optimization: convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP), convex relaxation, KKT conditions, duality.

UNIT-3

Gradient-based methods: Gradient descent, subgradient, mirror descent, Frank–Wolfe method, Nesterov's accelerated gradient method, ODE interpretations, dual methods, Nesterov's smoothing, proximal gradient methods, Moreau–Yosida regularization

Operator splitting methods: Augmented Lagrangian methods, alternating direction method of multipliers (ADMM), monotone operators, Douglas–Rachford splitting, primal and dual decomposition

UNIT-4

Stochastic and nonconvex optimization: Dual averaging, Polyak–Juditsky averaging, stochastic

variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems.

UNIT-5

Modern methods of Optimization: Evolutionary algorithms, Genetic Algorithms, Swarm Intelligence methods, Particle swarm optimization method, Grey Wolf Optimizer, Applications**.**
Real world applications of Image/Video/Multimedia Processing

SUGGESTED READINGS

- Stephen Boyd and Lieven Vandenberghe's book: Convex Optimization
- Nesterov's new book: Lectures on Convex Optimization
- Introduction to Nonlinear Optimization - Theory, Algorithms and Applications by Amir Beck
- K. Deb, 'Optimization for Engineering Design Algorithms and Examples', PHI, 2000
- Kulkarni, A. J., & Satapathy, S. C. (Eds.). (2020). Optimization in machine learning and applications (pp. 51-68). Heidelberg: Springer.
- Sra, S., Nowozin, S., & Wright, S. J. (Eds.). (2012). Optimization for machine learning. Mit Press.
- Jain, P., & Kar, P. (2017). Non-convex optimization for machine learning. Foundations and Trends® in Machine Learning, 10(3-4), 142-363.

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
CACSE56, COCSE60	**ED**	**Pattern Processing using AI**	**3**	**0**	**2**	**4**	**15**	**15**	**40**	**15**	**15**	**Python, Machine Learning**

COURSE OUTCOMES

1. Apply pattern recognition techniques to real-world problems such as document analysis and recognition. 2. Apply neural networks to pattern classification and regression problems.

- To apply knowledge representation and reasoning techniques
- To understand the design principles of pattern recognition with estimation and apply classification technique.
- Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

COURSE CONTENTS

UNIT-1

Introduction to Pattern Recognition: Fundamental concepts and blocks of a typical pattern recognition system. Decision functions- role and types, pattern and weight space, properties and implementation of decision functions.

UNIT-2

Basics of Probability, Random Processes and Linear Algebra: Probability: independence of events, conditional and joint probability, Bayes' theorem; Random Processes: Stationary and nonstationary

processes, Expectation, Autocorrelation, Cross-Correlation, spectra; Linear Algebra: Inner product, outer product, inverses, eigen values, eigen vectors.

Bayes Decision Theory: Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, discrete features

UNIT-3

Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case

Unsupervised learning: Criterion functions for clustering; Algorithms for clustering: K-Means, Hierarchical and other methods; Cluster validation; Gaussian mixture models; Expectation-Maximization method for parameter estimation; Maximum entropy estimation

UNIT-4

Sequential Pattern Recognition: Hidden Markov Models (HMMs); Discrete HMMs; Continuous HMMs

Nonparametric techniques for density estimation: Parzen-window method; K-Nearest Neighbour method

Dimensionality reduction: Fisher discriminant analysis; Principal component analysis; Factor Analysis

UNIT-5

Linear discriminant functions: Gradient descent procedures; Perceptron; Support vector machines

Non-metric methods for pattern classification: non-numeric data or nominal data; Decision trees: CART

List of Practicals:

- Write a python program to implement simple Chatbot.
- Write a program to implement k-means clustering from scratch.
- Generating samples of Gaussian (normal) distributions and plotting them for visualization
- Projects based on Fingerprint Pattern Recognition
- Project based on Handwritten Word Recognition
- Implement Decision Tree algorithms.
- Implement SVM.
- Implement Principal component analysis and use it for unsupervised learning
- Implement Maximum-Likelihood estimation.
- Implement agglomerative Hierarchical clustering.

SUGGESTED READINGS

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001
2. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
3. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006
4. S. Russel and P. Norvig, “Artificial Intelligence – A Modern Approach”, Second Edition,

Pearson Education
5. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995.
6. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem solving", Fourth Edition, Pearson Education.
7. Koller, D. and Friedman, N. Probabilistic Graphical Models. MIT Press. 2009.
8. R.J. Schalkoff. (1992) Pattern Recognition: Statistical, Structural, and Neural Approaches, Wiley.
9. L. Kuncheva. (2004) Combining Pattern Classifiers, Methods and Algorithms, Wiley

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
		Quantum Artificial Intelligence				4	25	25	50	-	-	Statistics, Probability Distributions, Sample Theory; Linear Algebra

COURSE OUTCOMES

- Understanding Conceptual Foundations of Quantum Systems.
- To be able to distinguish between quantum computing paradigms relevant for machine learning.
- Introduction of some of the core quantum computing algorithms, with a focus on coherent quantum machine learning.
- Use of Quantum Computing Techniques for training Deep Neural Networks.

COURSE CONTENTS:

UNIT I

Introduction: Quantum computing, Differences between quantum and classical computation, Potential performance gains of quantum vs. classical algorithms, key players of quantum technology, role of the quantum computing in artificial intelligence, How does Quantum AI works, Business applications of quantum AI, Critical milestones for quantum AI.

UNIT II

Qubits and Quantum model of computation: Quantum Superposition and Entanglement, time evolution of a closed system, composite system's measurement, mixed states and general quantum operations, quantum circuit models, quantum gates, universal sets of quantum gates, unitary transformations, quantum circuits.

UNIT III

Quantum Algorithms: Cirq, Qiskit, Quantum Random Number Generator, Deutsch-Jozsa Algorithm, Bernstein-Vajirani Algorithm, Bell's Inequality Test, Simon's Algorithm, Grover's Algorithm.

UNIT IV

Machine Learning Methods in Quantum Computing Theory: Introduction, Real Characteristics of Quantum Algorithms- SWAP-test, Quantum minimization algorithm (QMA), K-nearest neighbors (KNN), K-means algorithm.

UNIT V

Quantum Neural Networks: Current status and Prospects of Developments, Quantum Perceptron over a field, Neural Network Architecture selection in a Quantum Computer, Single-Hidden-Layer Feed-Forward Quantum Neural Network based on Grover Learning, Quantum Generalization of Feed Forward networks.

SUGGESTED READINGS

1. P. Kaye, R. Laflamme, and M. Mosca, "An introduction to Quantum Computing", Oxford University Press, 1999.

2. Quantum Computation and Quantum Information, M A Nielsen and I L Chuang.

3. Quantum Machine Learning: What Quantum Computing Means to Data Mining Book by Peter Wittek

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
	ED	Randomized Algorithms	3	0	2	4	15	15	40	15	15	COCSC 06

COURSE OUTCOMES

The objective of this course is to help the students to understand the power of randomization in the design and analysis of algorithms. Students will gain the knowledge about the fundamentals of randomized algorithm design, and the probabilistic tools and techniques used to analyse randomized algorithms.

COURSE CONTENTS

- To understand and use suitable mathematical tools used for designing randomized algorithms and analyse their performance.
- To understand some of the main paradigms used in the analysis of randomised algorithms, such as foiling an adversary, abundance of witnesses, fingerprinting, amplification, and random sampling.
- To design faster algorithms with weaker (but provable) performance guarantees for problems where the best known exact deterministic algorithms have large running times.
- To learn various data structures suitable for randomization
- To learn various approaches of Online Algorithms, Distributed Algorithms and Streaming Algorithms

COURSE CONTENTS

UNIT-I

Introduction and Game-Theoretic Techniques: Introduction to Randomized Algorithms, Min-Cut Algorithm, Monte Carlo, Las Vegas Algorithms, Binary Planar Partitions, A Probability Recurrence, Computation Model and Complexity Classes, Game tree Evaluation, minimax Principle, Randomness and Non-uniformity

Moments and Deviation: Occupancy Problems, Markov and Chebyshev Inequalities, Randomized Selection, Two-Point Sampling, Stable Marriage Problem, Coupon Collector's Problem, Stable Marriage, Markov Inequality, Chernoff Bound and applications

UNIT-II

Probabilistic Method: Overview, Maximum Satisfiability, Expanding Graphs, Oblivious Routing, Lovasz Local Lemma, Method of Conditional Probabilities

Markov Chains and Random Walks: 2-SAT Example, Markov Chains, Random Walks on Graphs, Electrical Networks, Cover Times, Graph Connectivity, Expanders and Rapidly Mixing Random Walks

UNIT-III

Algebraic Techniques: Fingerprinting and Freivalds Technique, Verifying Polynomial Identities, Perfect Matchings in Graphs, Verifying Equality of Strings, Comparison of

Fingerprinting Techniques, Pattern Matching

Approximate Counting: Randomized Approximation Schemes, DNF Counting Problem, Approximating the Permanent, Volume Estimation

UNIT-IV

Solutions to Data structuring Problems using Randomization: Fundamentals, Random Treaps, Skip Lists, Hash Tables, Universal Family of Hash Functions, Perfect Hashing

Genetic Algorithms and Linear Programming: Randomized Incremental Construction, Convex Hull in the Plane, Duality, Half-space Intersections, Delaunay Triangulations, Trapezoidal Decompositions, Binary Space Partitions, Diameter of a Point Set, Random Sampling, Liner Programming

UNIT-V

Online Algorithms: Online Paging Problem, Adversary models, Paging against an Oblivious Adversary, Adaptive Online Adversary, The k-server problem.

Distributed Algorithms: Symmetry Breaking problems like leader election, Byzantine agreement, maximal independent set, and colouring; Algorithms for dynamic networks; the k-machine model for processing large graphs.

Streaming Algorithms: The streaming model, approximate counting, reservoir sampling, AMS sketching.

References and Text Books:

- Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms", Cambridge University Press, 1995
- Michael Mitzenmacher and Eli Upfal, "Probability and Computing:Randomized Algorithms and Probabilistic Analysis", Cambridge University Press, 2005

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
CACSE57	**ED**	**Responsible AI**	**3**	**0**	**2**	**4**	**15**	**15**	**40**	**15**	**15**	

COURSE OUTCOMES

1. Describe the reasons for an ethical analysis applied to AI.
2. Use critical skills in clarifying and ethically analysing AI in different domains of life.
3. Identify the ethical and social impacts and implications of AI.
4. Critically analyse the current policies for AI and use ethical and socially responsible principles in your professional life.

COURSE CONTENTS

UNIT-1 Introduction, What Is Artificial Intelligence: - Introduction, The Background of AI Autonomy Adaptability, Interaction .

Ethical Decision-Making: - Introduction Ethical Theories Values Ethics in Practice. Implementing Ethical Reasoning.

UNIT-2 Taking Responsibility: Introduction Responsible Research and Innovation, The ART of AI: Accountability, Responsibility, Transparency, Design for Values

Can AI Systems Be Ethical: Introduction What Is an Ethical Action? Approaches to Ethical Reasoning by AI, Designing Artificial Moral Agents, Ethical Deliberation, Levels of Ethical Behavior, The Ethical Status of AI Systems.

UNIT-3 Ensuring Responsible AI in Practice: Introduction, Governance for Responsible AI, Codes of Conduct, Inclusion and Diversity, The AI Narrative, Humankind's relationship with technology, AI and Societ, Super-intelligence
Back boxes in AI, Biases of AI algorithm.

UNIT-4 issue and challenges: Challenges posed by automated weaponry and vehicles: risk, responsibility, and control, doping in sport, Genetic selection, enhancement, and eugenics, Feminist perspectives on reproductive technologies, Technology and human relationships, from sex robots to care work, The impact of automation on labour and inequality, The impact of technology on democracy, Pandemic ethics.

UNIT-5 Governance and policies**:**from AI ethics to AI governance,AI ethics principles, where ethics and regulation meet, regulating experiment vs regulating technology, policy option,fairness,accountability and transparency ,analysis in AI regulation

List of practical (for 302 LTP only):

- .

SUGGESTED READINGS

- 1.Towards a Code of Ethics for Artificial Intelligence,*by Paula Boddington*
- AI ETHICS **Paperback,mark Coelckburg**
- *Heartificial Intelligence: Embracing Our Humanity to Maximise Machines* **(2016) by John C Haven**
- *Artificial Unintelligence: How Computers Misunderstand the World by* **Meredith Broussard**

Course Code	Type	Subject	L	T	P	Credits	TCA	TMS	TES	PCA	PES	Pre-requisites
	ED	Service Oriented Architecture	3	1	0	4	25	25	50	0	0	Computer Networks, Operating Systems

COURSE OUTCOMES

1. Understand the basic principles of service orientation and service-oriented analysis techniques
2. Gain an insight in the technology underlying the service design and learn advanced concepts such as service composition, orchestration and choreography
3. Acquire skills to apply various components of service-oriented architecture such as SOAP, Entity-centric business service design, application service design and their combination to implement the solutions.
4. Ability to plan, analyze and design enterprise software applications based on service–oriented architecture.
5. Learning the emerging trends in service-oriented architecture.

COURSE CONTENT

UNIT-I
Introduction: Roots of SOA, Characteristics of SOA, Comparing SOA to client-server and distributed internet architectures, Anatomy of SOA, How components in an SOA interrelate, Principles of service orientation

UNIT-II
Web services: Service descriptions, Messaging with SOAP, Message exchange Patterns, Coordination, Atomic Transactions, Business activities, Orchestration, Choreography, Service layer abstraction, Application Service Layer, Business Service Layer, Orchestration Service Layer

UNIT-III
Service oriented analysis: Business-centric SOA, Deriving business services, service modeling, Service Oriented Design, WSDL basics, SOAP basics, SOA composition guidelines, Entity-centric business service design, Application service design, Task- centric business service design

UNIT-IV
SOA platform basics: SOA support in J2EE, Java API for XML-based web services (JAX-WS), Java architecture for XML binding (JAXB), Java API for XML Registries (JAXR) , Java API for XML based RPC (JAX-RPC).

UNIT-V
WS-BPEL basics: WS-Coordination overview, WS-Choreography, WS-Policy, WSSecurity Emerging trends

REFERENCES AND TEXTBOOKS:
1. Thomas Erl, “Service-Oriented Architecture: Concepts, Technology, and Design,” Pearson Education. 2. Papazoglou, Mike , “Web Services & SOA: Principles and Technology ,” Pearson – Prentice Hall.
3. Bell, Michael , “Service-Oriented Modeling (SOA): Service Analysis, Design, and Architecture,” Wiley. 4. Erl, Thomas , “SOA Design Patterns,” Prentice Hall .

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	Pre-requisites

	ED	SOFTWARE REUSE AND RE-ENGINEERING	3	1	0	4	25	25	50	Software Engineering, and Object Oriented Concepts

COURSE OUTCOMES

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

1. Gain knowledge on:

- Component System Engineering
- Application System Engineering
- Application Family Engineering
- Managing reuse

2. Analyze complex legacy software systems to identify reusable components.

3. To introduce student to the fundamental principles and methodologies of a software maintenance and reengineering.

UNIT I

BUSINESS Software Reuse success factors: Software reuse a simple idea, A systematic approach makes pragmatic reuse work, Reuse requires changes n process, Reuse requires changes in organization, Adopting Reuse, Set of principles. Reuse Driven Software Engineering is a Business: Make Reuse cost effective, Reuse business characteristics, Architect Components and Applications, Software Engineering processes

UNIT II

Object Oriented Software Engineering, Application and Component System, Use case Components. Object Components: Object models define system architecture and design, Reusing Analysis and design components, Expressing variability in object model components, Tracing use case variability to the object model, Reusable analysis components, Reusable design and implementation components, Layered Architecture.

UNIT III

Object Oriented Business Engineering, Applying Business Engineering to Define Processes and Organization, Software Maintenance Process Models: Lifecycle, Evolution Process, change request, Regression Testing, System Testing, Acceptance Testing

UNIT IV

Re-engineering Process, Source code translation, Reverse engineering: Reverse Engineering vs Forward Engineering, Program modularization, Data re-engineering Process, Data Migration, Data Restructuring

UNIT V

Transition to a Reuse Business, Managing the Reuse Business, Software Reuse and Maintainability Issues Design Patterns, Frameworks, Program, Software Quality Measures, Establishing and Managing a Reuse business.

SUGGESTED READINGS:

- var Jacobson, Martin Gress, Patrick Johnson, "Software Reuse," Pearson Education, 2004.
- Eve-Andre Karisson, "Software Reuse – A Holistic Approach," John Wiley and Sons, 1996.
- Karma McClure, "Software Reuse Techniques – Additional reuse to the systems development process," Prentice Hall, 1997.

Course No.	Type	Subject	L	T	P	Credits	CA	MS	ES	CA	ES	Pre-requisites
COCSE63	**ED**	**System Simulation**	**3**	**0**	**2**	**4**	**15**	**15**	**40**	**15**	**15**	**None**

COURSE OUTCOMES

- To learn the basic concepts, applications and terminology of computer simulation
- To learn statistical methods of estimation and testing and other relevant concepts
- To explain the working and applications of different types of simulation such as Monte Carlo, VS. Discrete Event
- You will learn to analyze input data, its parameters, and the use of random number in a typical simulation study.
- Student will learn different techniques for the Verification and Validation of a simulation study

COURSE CONTENTS

UNIT-1: Introduction to Simulation: Simulation: Definition, Methods, Systems, Variability, Complexity, Advantages. Modelling: Definition, characteristics, description, categories**.**

UNIT-2: Statistical Concepts: Hypothesis, Estimation, Statistical Significance, Error/Risks. Statistical tests, Bounds and Correlation. Input Data Modelling, Output Data Analysis

UNIT-3: Discrete-Event Simulation, Monte Carlo Simulation: Queuing System Model Components, Simulation Methodology, DES Example, Implementation, Arena Simulation. The Monte Carlo Method, Sensitivity Analysis

UNIT-4: Data Collection and Analysis: Obtaining Data, Data Format, Representing Unpredictable Variability, Distributions, Bootstrapping, Fitting Statistical Distributions to Empirical Data

UNIT-5: Verification, Validation, and Accreditation: Definition and concepts, Difficulties, Confidence as Validity. Conceptual Model Validation, Data Validation, White-Box Validation, Black-Box Validation, Experimentation Validation, Solution Validation, Independent Verification and Validation

List of practical (for 302 LTP only):

- Simpy getting started
- Develop a simple simulation and simulation tracing program
- Develop a program for executing simulations event by event

- Implement synchronizing simulation time with wallclock time
- Develop an event stepping of models with a GUI
- Implement debugging and GUI for SimPy simulations
- Plot for simulation, statistical parameters
- Implement Inference and output monitoring
- Develop a DES simulation on simpy
- Implement a simpy internal network
- Develop a program for Machine breakdown,
- Generate a program of car wash, cell phone network and resource pool
- Group project

SUGGESTED READINGS

- http://ce.sharif.edu/courses/95-96/2/ce6341/resources/root/Books/Discrete%20Event%20System%20Simulation%20(Fifth%20Edition)%20.pdf
- Modeling and Simulation: Exploring Dynamic System Behavior, Authors: Birta, Louis G., Arbez, Gilbert 2. Simulation (5th Edition), Authors: Sheldon Ross
- Link to NPTEL course contents: https://nptel.ac.in/courses/106104019/, Link to topics related to course: i. https://nptel.ac.in/courses/106104019/1 ii. https://nptel.ac.in/courses/106104019/4 iii. https://nptel.ac.in/courses/106104019/26 iv. https://nptel.ac.in/courses/106104019/2Ev
- Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: Fundamentals of Computer Algorithms, 2nd Edition, Universities press, 2007 11. https://nptel.ac.in/courses/106104019/26
- https://nptel.ac.in/courses/106104019/2Ev