Department of Computer Sc. & Engg. and Information Technology
Minor Program in CSE

Minor program in CSE consist the following major disciplines in which student has to complete 14 mandatory credits and 6 non-mandatory credits to complete total 20 additional credits.

Subject Code	Type	Semester	Name of the Subject(s)	Credits
18B11CI412	Mandatory	4	Design & Analysis of Algorithms	3
18B17CI472	Mandatory	4	Design and Analysis of Algorithms Lab	2
18B11CI513	Mandatory	5	Formal Language & Automata Theory	3
18B1WCI575	Mandatory	5	Multimedia Lab	1
18B11CI612	Mandatory	6	Compiler Design	3
18B17CI672	Mandatory	6	Compiler Design Lab	2
18B1WCI733	Non-Mandatory	7	Advanced Algorithms	2
18B1WCI773	Non-Mandatory	7	Advanced Algorithms Lab	1
18B1WCI740	Non-Mandatory	7	Computational Techniques and Algorithms in Engineering	3
18B1WCI834	Non-Mandatory	8	Network Management	3
18B1WCI831	Non-Mandatory	8	Data Analytics	3
			TOTAL	**14+6**

Minor program in IT

Minor program in IT consist the following major disciplines in which student has to complete 14 mandatory credits and 6 non-mandatory credits to complete total 20 additional credits.

Category Code	Type	Semester	Name of the Subjects	Credits
18B1WCI639	Mandatory	4	Software Engineering Practices	3
18B1WCI679	Mandatory	4	Software Engineering Practices Lab	2
18B11CI512	Mandatory	5	Information Systems	3
18B17CI572	Mandatory	5	Information Systems Lab	1
18B11CI613	Mandatory	6	Data Mining	3
18B17CI673	Mandatory	6	Data Mining Lab	2
	Non-Mandatory	7	Building IoT and Network Applications	2
	Non-Mandatory	7	Building IoT and Network Applications Lab	1
	Non-Mandatory	7	An Introduction to Statistical learning	3
	Non-Mandatory	8	Foundations of Blockchain	3
	Non-Mandatory	8	Fog Computing in IoT	3
			TOTAL	**14+6**

Proficiency Courses in CSE & IT Discipline

Proficiencies proposed and the elective courses relevant to each proficiency are outlined below. A student is required to take 50% of the electives in the regular curricula from the list of courses prescribed for each proficiency.

i. Proficiency in Information Security

As digital information moves to a more networked and globalized infrastructure, it is essential that one should understand the threats to this information. The creation of effective corporate- wide security plans with well established security programs, policies, controls, and procedures as well as awareness and training initiatives is getting more focus with the rising demand of Information security professionals.

Proficiency in Information security consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credits
Elective -1	18B1WCI532	5th Sem	Data Compression	2
Elective -1	18B1WCI572	5th Sem	Data Compression Lab	1
Elective -2	19B1WCI631	6th Sem	Digital Forensics	2
Elective -2	19B1WCI671	6th Sem	Digital Forensics lab	1
Elective -3	19B1WCI632	6th Sem	Information Security	2
Elective -3	19B1WCI672	6th Sem	Information Security Lab	1
Elective -4	18B1WCI734	7th Sem	Cryptography& network security	2
Elective -4	18B1WCI774	7th Sem	Cryptography& network security Lab	1
Elective -5	19B1WCI736	7th Sem	Information Auditing & Risk Management	3
Elective -6	19B1WCI831	8th Sem	Ethics and Information Technology	3

ii. Proficiency in Data Sciences

Unlike classical statistics, the need to process and manage massive amounts of data has become a key feature of modern statistics. Data Science provides a foundation for problem- solving in a data-driven society. Data Science applies core concepts in computer science, statistics and mathematics to problems in a wide variety of fields, from physical, social, biomedical, and behavioral sciences to arts and humanities. This proficiency will enable students with preliminary data collection, manipulation, access and/or analysis skills as are appropriate to data needs in their majors.

Proficiency in Data Sciences consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credits
Elective -1	20B1WCI531	5th Sem	Foundation for Data Science and Visualization	2
Elective -1	20B1WCI571	5th Sem	Data Science and Visualization Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	20B1WCI732	6th Sem	From Graph to Knowledge Graph	2
Elective -3	20B1WCI772	6th Sem	From Graph to Knowledge Graph Lab	1
Elective -4	19B1WCI731	7th Sem	Computational Data Analysis	2
Elective -4	19B1WCI771	7th Sem	Computational Data Analysis lab	1
Elective -5	19B1WCI737	7th Sem	Optimization Methods in Business Analytics	3
Elective -6	18B1WCI832	8th Sem	Social and Information Network Analysis	3

iii. Proficiency in Machine Learning

Rising demand of Machine learning (ML) have exploded in importance in recent years and garnered attention in a wide variety of application in diverse areas such as bioinformatics, fraud detection, intelligent systems, perception, finance, information retrieval, and other areas. This proficiency will allow undergraduates to learn about the core principles of machine learning.

Proficiency in machine learning consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	20B1WCI531	5th Sem	Foundation for Data Science and Visualization	2
Elective -1	20B1WCI571	5th Sem	Data Science and Visualization Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	18B1WCI635	6th Sem	Data Mining & Data Warehousing	2
Elective -3	18B1WCI675	6th Sem	Data Mining & Data Warehousing Lab	1
Elective -4	18B1WCI734	7th Sem	Cryptography& network security	2
Elective -4	18B1WCI774	7th Sem	Cryptography& network security Lab	1
Elective -5	19B1WCI736	7th Sem	Information Auditing & Risk Management	3
Elective -6	19B1WCI832	8th Sem	Probabilistic Graphical Models	3

iv. Proficiency in Computer Graphics

Computer Graphics provides an exciting and rapidly developing industry with myriad opportunities for working in film and TV, scientific and medical visualisation, computer games and the web. This proficiency will allow undergraduates to focus on producing computer-generated graphics and is particularly useful for those interested in animation, and game designing.

Proficiency in computer graphics consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	20B1WCI531	5th Sem	Foundation for Data Science and Visualization	2
Elective -1	20B1WCI571	5th Sem	Data Science and Visualization Lab	1
Elective -2	19B1WCI633	6th Sem	Computer Animation	2
Elective -2	19B1WCI673	6th Sem	Computer Animation Lab	1
Elective -3	18B1WCI636	6th Sem	Digital Image processing	2
Elective -3	18B1WCI676	6th Sem	Digital Image processing Lab	1
Elective -4	19B1WCI732	7th Sem	Game Development and Design	2
Elective -4	19B1WCI772	7th Sem	Game Development Lab	1
Elective -5	18B1WCI840	7th Sem	Computer Vision	3
Elective -6	19B1WCI833	8th Sem	Information Modeling	3

v. Proficiency in Big Data and Visual Analytics

Big Data and Business Analytics is a fast growing field with applications in business decision making, patient care, political decision making, criminal justice, IT security etc. This proficiency provides knowledge of key concepts, methods, techniques, and tools of big data and visual analytics from organization perspective to the various undergraduates.

Proficiency in big data and visual analytics consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	19B1WCI531	5th Sem	Big Data using Hadoop	2
Elective -1	19B1WCI571	5th Sem	Big Data using Hadoop Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	18B1WCI635	6th Sem	Data Mining & Data Warehousing	2
Elective -3	18B1WCI675	6th Sem	Data Mining & Data Warehousing Lab	1
Elective -4	19B1WCI731	7th Sem	Computational Data Analysis	2
Elective -4	19B1WCI771	7th Sem	Computational Data Analysis lab	1
Elective -5	19B1WCI738	7th Sem	Introduction to Deep Learning	3
Elective -6	19B1WCI834	8th Sem	Information Visualization	3

vi. Proficiency in Image Analysis and Processing

Recent explosive growth of digital imaging technology makes the problems of automated image interpretation more exciting and relevant than ever. Image analysis and processing is a highly interdisciplinary field of study that incorporates elements from mathematics, engineering, and computer science to understand, design, and utilize imagery and imaging systems to study scientific phenomena. This proficiency provides knowledge of modern methods of automatic processing and analysis of digital images and video, and methods of image understanding and computer vision to the various undergraduates.

Proficiency in image analysis and processing consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	19B1WCI532	5th Sem	Image Analysis and Pattern Recognition	2
Elective -1	19B1WCI572	5th Sem	Image Analysis and Pattern Recognition Lab	1
Elective -2	19B1WCI634	6th Sem	Computer and Robot Vision	2
Elective -2	19B1WCI674	6th Sem	Computer and Robot Vision lab	1
Elective -3	18B1WCI636	6th Sem	Digital Image processing	2
Elective -3	18B1WCI676	6th Sem	Digital Image processing Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	18B1WCI840	7th Sem	Computer Vision	3
Elective -6	19B1WCI834	8th Sem	Information Visualization	3

vii. Proficiency in Cloud Computing

With the wide usage of Internet and the increasing popularity of mobile computing devices (e.g. smartphones, tablets, and laptops) in society, computer users are migrating their computing usage and data storage from a single personal computing environment to a web- based, distributed and networked computing environment. This proficiency will equip undergraduates with the essential knowledge of cloud computing and various tools and technologies.

Proficiency in cloud computing consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	20B1WCI532	5th Sem	Cloud Computing: Concepts, Technology & Architecture	2
Elective -1	20B1WCI572	5th Sem	Cloud Computing: Concepts, Technology & Architecture Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	19B1WCI635	6th Sem	Architecting Distributed Cloud Applications	2
Elective -3	19B1WCI675	6th Sem	Architecting Distributed Cloud Applications Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	18B1WCI736	7th Sem	Storage Networks	3
Elective -6	19B1WCI835	8th Sem	Cloud Computing Security	3

viii. Proficiency in Human Computer Interaction

Human-Computer Interaction (HCI) is the study of how humans interact with technology through principled design, communication, and construction. HCI addresses the design, evaluation, and implementation of computer based systems for the benefit of human use. This proficiency provides undergraduates core knowledge about techniques for building successful user interfaces.

Proficiency in human computer interaction consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	19B1WCI533	5th Sem	Human-Computer Interaction	2
Elective -1	19B1WCI573	5th Sem	Human-Computer Interaction Lab	1
Elective -2	19B1WCI636	6th Sem	Computability, Complexity & Algorithms	2
Elective -2	19B1WCI676	6th Sem	Computability, Complexity & Algorithms Lab	1
Elective -3	18B1WCI638	6th Sem	Pattern Recognition	2
Elective -3	18B1WCI678	6th Sem	Pattern Recognition Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	18B1WCI840	7th Sem	Computer Vision	3
Elective -6	19B1WCI836	8th Sem	Knowledge-Based AI: Cognitive Systems	3

ix. Proficiency in Artificial Intelligence

With the rapid increase in data volumes, advanced algorithms, and improvements in computing power and storage have made possible for machines to learn from experience and perform human-like tasks. Artificial Intelligence has fulfilled this dream which can be applied to almost every field. This proficiency introduces students to the techniques of artificial intelligence programming and the basic theoretical concepts of artificial intelligence, knowledge representation, and automated reasoning.

Proficiency in artificial intelligence consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	20B1WCI531	5th Sem	Foundation for Data Science and Visualization	2
Elective -1	20B1WCI571	5th Sem	Data Science and Visualization Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	19B1WCI637	6th Sem	Statistics and Exploratory Data Analytics	2
Elective -3	19B1WCI677	6th Sem	Statistics and Exploratory Data Analytics Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	19B1WCI738	7th Sem	Introduction to Deep Learning	3
Elective -6	19B1WCI837	8th Sem	Reinforcement Learning	3

x. Proficiency in Social Computing

The collaborative exchange of ideas is essential to the success of difficult initiatives, including software architecture and design, project management and organizational transformation. Technology has made collaboration at a distance possible in new ways that present their own set of challenges. Social computing is concerned with systems of this sort and the mechanisms and principles that underlie them. This proficiency introduces undergraduates to the major challenges and opportunities for creating online communities.

Proficiency in social computing consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	19B1WCI534	5th Sem	Social Media	2
Elective -1	19B1WCI574	5th Sem	Social Media Lab (Node XL)	1
Elective -2	19B1WCI638	6th Sem	Statistics and Data Science	2
Elective -2	19B1WCI678	6th Sem	Statistics and Data Science Lab	1
Elective -3	20B1WCI732	6th Sem	From Graph to Knowledge Graph	2
Elective -3	20B1WCI772	6th Sem	From Graph to Knowledge Graph Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	18B1WCI737	7th Sem	Cloud Computing	3
Elective -6	18B1WCI832	8th Sem	Social and Information Network Analysis	3

Statistics and Data Science

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0
Pre-requisite: Basic knowledge of High School Mathematics and reasonable programming experience.

Course Objectives:

1. Understand the Fundamentals of Statistics
2. Understand the Probability for Data Analysis
3. Learn how to work with Different Types of Data
4. Different Types of Distributions
5. Apply Statistical Methods and Hypothesis Testing to Business Problems
6. Understand all the concepts of Statistics for Data Science and Analytics
7. Working of Regression Analysis
8. Implement one way and two way ANOVA
9. Chi-Square Analysis
10. Central Limit Theorem

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand all the concepts of Statistics for Data Science and Analytics	Familiarity
CO-2	Compute the probabilities of events along with an understanding of the random variables, expectation, variance, and distributions.	Usage
CO-3	Identify probability distributions commonly used as foundations for statistical modeling.	Assessment
CO-4	Apply Statistical Methods and Hypothesis Testing to Business Problems	Usage
CO-5	Broaden the knowledge about Random Variables, Joint Distributions, Special Distributions	Assessment
CO-6	To have hands-on skills on Illustrative example for data analysis(Implementation of statistical techniques, data interpretation, Regression Analysis, Covariance, Hypothesis testing and analysis of variance)	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** What is Data Science? - Big Data and Data Science hype – and getting past the hype - Why now? – Datafication - Current landscape of perspectives - Skill sets needed **Probability:** Classical, relative frequency, and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.	4
2	**Random Variables:** Discrete, continuous, and mixed random variables, probability mass, probability density, and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median, and quantiles, Markov inequality, Chebyshev's inequality, problems, Function of a random variable, problems.	5
3	**Special Distributions:** Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Weibull, Pareto, beta, normal, lognormal, inverse Gaussian, Cauchy, double exponential distributions, reliability and hazard rate, reliability of series and parallel systems, problems.	4
4	**Joint Distributions:** Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems**.**	4
5	**Sampling Distributions:** The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems	5
6	**Testing of Hypotheses:** Null and alternative hypotheses, the critical and 8 acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chisquare goodness of fit test and its applications, problems.	6
	Total Lecture Hours	**28**

Suggested Text Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E.Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability and Statistics by J.S. Milton & J.C. Arnold, Boston, London, McGraw-Hill, (2006), 4th ed.
- Data Science and analytics with python by Jesus Rogel-Salazar.

Suggested Reference Book(s):

- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

- Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross, Elsevier, (2014), 4th ed.
- Python Data Science Handbook by Jake VanderPlas, 2017.

Other useful resource(s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/pr eview
- https://bit.ly/2GvlBfs
- https://bit.ly/3aONiOo

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Statistics and Data Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	1	1.9
CO-3	2	2	2	2	1	1	1	1	2	2	1	2	1.6
CO-4	3	3	3	3	2	1	1	1	2	3	3	2	2.3
CO-5	2	3	3	3	1	1	1	1	2	3	2	2	2
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2.2	2.7	2.7	2.7	1.8	1	1	1	2	2.5	1.8	1.8	1.9

Statistics and Data Science Lab

COURSE CODE: XXXXXXXX COURSE CREDITS: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2

Pre-requisite: Basics of programming in R or Python

Course Objectives:

1. Understand the fundamentals of statistics and apply them in practice
2. To analyze the data using different descriptive measures and present graphically.
3. Compute the probabilities of events along with an understanding of the random variables, expectation, variance and distributions.
4. Understand the estimation of mean and variance and their respective one-sample and k sample hypothesis tests.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand basics of Python or R syntax, functions and programming	Familiarity
CO2	Learn the core tools for data science with R or Python	Usage
CO3	Understand and carry out regression analysis	Usage
CO4	Visualize data: plot different types of data & draw insights	Usage
CO5	Hypothesis testing in R or Python	Usage
CO6	Analyze the systems using Laplace transform and Z-transform.	Usage

List of Experiments

S. No.	Description	Hours
1	Introduction to the basics of Python or R syntax, functions, and programming.	**2**
2	Introduction various packages are available for statistical analysis. (e.g. “stats” package in R, Lib/statistics.py package in python)	**2**
3	Implementation of statistical techniques using statistical packages.	**2**
4	Evaluation of Statistical Parameters and data interpretation	**2**
5	Regression Analysis	**2**
6	Covariance Analysis	**2**
7	Hypothesis testing	**2**
8	Analysis of variance	**2**
9	Introduction to Numpy in Python	**2**
10	Data Manipulation with Pandas	**2**
11	Data Visualization with Matplotlib	**2**
12	Introduction to Data Preprocessing	**2**
13	Introduction to Machine Learning Models	**2**

14	Introduction to model cross-validation and model performance analysis	**2**
	Total Lab Hours	**28**

Suggested/Resources:

- Python Data Science Handbook by Jake VanderPlas, 2017.
- Data Science and analytics with python by Jesus Rogel-Salazar.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.
- https://bit.ly/3aONiOo
- https://bit.ly/2GvlBfs
- https://bit.ly/2uIJuxg

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Digital Forensics

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0
Pre-requisite: Cryptography and Security, Computer Networks

Course Objectives:

1. To understand underlying principles and many of the techniques associated with digital forensic practices and cybercrime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cybersecurity issues (Computer Security Incident) and analyzed the ways that exploit insecurities.
5. To investigate attacks, IDS .technical exploits and router attacks and "Trap and Trace" computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to Cyber Crime and Ethical Hacking	Familiarity
CO-2	Introduction to Digital Forensics and Digital Evidences	Familiarity
CO-3	Computer Security Incident Response Methodology	Assessment
CO-4	Forensic Duplication and Disk Analysis, and Investigation Data Analysis	Assessment
CO-5	Network Forensics Incidents, Using Routers as Response Tools	Usage
CO-6	Forensic Investigation Report and Forensic Tools	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Introduction of Cybercrime: Types of cybercrime, categories of cybercrime, Computers' roles in crimes, Prevention from Cybercrime, Hackers, Crackers, Phreakers Ethical Hacking: Difference between Hacking and Ethical hacking: Steps of Ethical Hacking, Exploring some tools for ethical hacking: reconnaissance tools, scanning tools	5
2	Digital Forensic, Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics,	5

	Digital Evidences: Types and characteristics and challenges for Evidence Handling	
3	Introduction to Computer Security Incident Goals of Incident Response, Incident Response Methodology, Formulating Response Strategy, IR Process – Initial Response, Investigation, Remediation, Tracking of Significant, Investigative Information, Reporting Pre Incident Preparation, Incident Detection, and Characterization. Live Data Collection: Live Data Collection on Microsoft Windows Systems: Live Data Collection on Unix-based Systems	**5**
4	Forensic Duplication Forensic Image Formats, Traditional Duplication, Live System Duplication, Forensic Duplication tools Disk and File System Analysis: Media Analysis Concepts, File System Abstraction Model The Sleuth Kit: Installing the Sleuth Kit, Sleuth Kit Tools Partitioning and Disk Layouts: Partition Identification and Recovery, Redundant Array of Inexpensive Disks Special Containers: Virtual Machine Disk Images, Forensic Containers Hashing, Carving: Foremost, Forensic Imaging: Deleted Data, File Slack, Data Analysis, Analysis Methodology Investigating Windows systems, Investigating UNIX systems, Investigating Applications, Web Browsers, Email, Malware Handling: Static and Dynamic Analysis	**5**
5	Technical Exploits and Password Cracking, Introduction to Intrusion Detection systems, Types of IDS Understanding Network intrusion and attacks, Analyzing Network Traffic, Collecting Network-based evidence, Evidence Handling. Investigating Routers, Handling Router Table Manipulation Incidents, Using Routers as Response Tools	**4**
6	Report: Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report. Computer Forensic Tools: need and types of computer forensic tools, tasks performed by computer forensic tools. Study of open-source Tools like SFIT, Autopsy, etc. to acquire, search, analyze and store digital evidence	**4**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Jason Luttgens, Matthew Pepe, Kevin Mandia, “Incident Response and computer forensics”,3rd Edition Tata McGraw Hill, 2014.
- Nilakshi Jain, Dhananjay Kalbande, ”Digital Forensic: The fascinating world of Digital Evidences ” Wiley India Pvt Ltd 2017.
- Cory Altheide, Harlan Carvey ”Digital forensics with open source tools “Syngress Publishing, Inc. 2011.
- Chris McNab, Network Security Assessment, By O'Reilly.

Suggested Reference Book(s):

- Clint P Garrison “Digital Forensics for Network, Internet, and Cloud Computing A forensic evidence guide for moving targets and data , Syngress Publishing, Inc.2010
- Bill Nelson,Amelia Phillips,Christopher Steuart, “Guide to Computer Forensics and Investigations” . Cengage Learning, 2014
- Debra Littlejohn Shinder Michael Cross “Scene of the Cybercrime: Computer Forensics Handbook”, 2nd Edition Syngress Publishing, Inc.2008.
- Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Digital Forensics Lab

COURSE CODE: XXXXXXXX COURSE CREDITS: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2
Pre-requisite: Cryptography and Security, Computer Networks

Course Objectives:

1. To understand underlying principles and many of the techniques associated with digital forensic practices and cybercrime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cybersecurity issues (Computer Security Incident) and analyzed the ways that exploit insecurities.
5. To investigate attacks, IDS .technical exploits and router attacks and "Trap and Trace" computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to Cyber Crime and Ethical Hacking	Familiarity
CO-2	Introduction to Digital Forensics and Digital Evidences	Familiarity
CO-3	Computer Security Incident Response Methodology	Assessment
CO-4	Forensic Duplication and Disk Analysis, and Investigation Data Analysis	Assessment
CO-5	Network Forensics Incidents, Using Routers as Response Tools	Usage
CO-6	Forensic Investigation Report and Forensic Tools	Usage

Course Contents:

Unit	Contents	Hours
1	Use a Web Search Engine, and search for companies specializing in computer forensics. Select three and write a two-to-three paper comparing what each company does.	**2**
2	Search the internet for articles on computer crime prosecutions. Find at least two. Write one or two pages summarizing the two articles and identify the key features of the decisions you find in your search.	**2**
3	Using a search engine, search for various computer forensics tools.	**2**
4	Preparing and processing of investigations. Try to examine and identify the evidence from the drives.	**2**
5	Extracting of files that have been deleted.	**2**
6	Illustrate any data acquisition method and validate it. Use an open-source	**2**

	data acquisition tool.	
7	You're investigating an internal policy violation when you find an e-mail about a serious assault for which a police report needs to be filed. What should you do? Write a two-page paper specifying who in your company you need to talk to first and what evidence must be turned over to police.	**2**
8	Create a file on a USB drive and calculate its hash value using FTK Imager. Change the file and calculate the hash value again to compare the files.	**2**
9	Compare two files created in Microsoft office to determine whether the files are different at the hexadecimal level. Keep a log of what you find.	**2**
10	Illustrate the analysis of forensics data.	**2**
11	Illustrate the validating of forensics data.	**2**
12	Locate and extract (JPEG) files with altered extensions.	**2**
13	Examine an E-mail message.	**2**
14	Investigate an E-mail message.	**2**
	Total Lab Hours	**28**

Suggested Text Book(s):

- "Computer Forensics and Investigations", Nelson, Phillips Enfinger, Steuart, Cengage Learning.

Suggested Reference Book(s):

- Brian Carrier, "File System Forensic Analysis" , Addison Wesley, 2005
- Dan Farmer & Wietse Venema ,"Forensic Discovery", Addison Wesley, 2005
- Eoghan Casey , ―Digital Evidence and Computer Crime ―, Edition 3, Academic Press, 2011
- Chris Pogue, Cory Altheide, Todd Haverkos ,Unix and Linux Forensic Analysis DVD ToolKit, Syngress Inc. , 2008
- Harlan Carvey ,Windows Forensic Analysis DVD Toolkit, Edition 2, Syngress Inc. , 2009
- Harlan Carvey ,Windows Registry Forensics: Advanced Digital Forensic Analysis of the Windows
- Registry , Syngress Inc, Feb 2011
- Eoghan Casey, Handbook of Digital Forensics and Investigation, Academic Press, 2009
- M Sonka, V Hlavac and R Boyle, Image Processing, Analysis and Machine Vision, PWS
- Pratt.W.K., Digital Image Processing, John Wiley and Sons, New York, 1978

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Foundation for Data Science and Visualization

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0

Pre-requisite: Basic knowledge of high school mathematics and reasonable programming experience.

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into the usable and desired form	Usage
CO-4	Using data visualization to easily access the huge amount of data in visuals	Usage
CO-5	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-6	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Data Science an Introduction:** Computer Science, Data Science, and Real Science, What is Data Science? Need for Data Science, Data Science Components, Tools for Data Science, Data Science Lifecycle, Applications of Data Science	2

2	**Python and R Programming for Data Science for Data Science:** Introduction to Python Programming (Python Basics, Python Data Structures, Python Programming Fundamentals, Working with Data in Python, Working with NumPy, Pandas, SciPy, and Matplotlib). Introduction to R Programming (R basics, Data structures in R, R Programming fundamentals, Working with Data in R, Stings, and Dates in R, Discover R's packages to do graphics)	**5**
3	**Data Processing:** Data Operations, Data cleansing, Processing CSV Data, Processing JSON Data, Processing XLS Data, Relational databases, NoSQL Databases, Date and Time, Data Wrangling, Data Aggregation, Reading HTML Pages, Processing Unstructured Data, Word tokenization, Stemming and Lemmatization	**5**
4	**Statistical Data Analysis:** Measuring Central Tendency, Measuring Variance, Normal Distribution, Binomial Distribution, Poisson Distribution, Bernoulli Distribution, P-Value, Correlation, Chi-square Test, Linear Regression	**5**
5	**Linear Algebra:** Visualizing Matrix Operations (Matrix Addition, Matrix Multiplication, Applications of Matrix Multiplication, Identity Matrices and Inversion, Matrix Inversion and Linear Systems, Matrix Rank) Factoring Matrices (Why Factor Feature Matrices, LU Decomposition, and Determinants), Eigenvalues and Eigenvectors (Properties of Eigenvalues, Computing Eigenvalues), Eigenvalue Decomposition (Singular Value Decomposition, Principal Components Analysis)	**5**
6	**Data Visualization:** Chart Properties, Chart Styling, Box Plots, Heat Maps, Scatter Plots, Bubble Charts, 3D Charts, Time Series, Geographical Data, Graph Data	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Data Science from Scratch by Joel Grus
- Data Science for Dummies by Lillian Pierson and Jake Porway
- An Introduction to Statistical Learning by Gareth James, Daniela Witten, et al.

Reference Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

Other useful resources (s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/pr eview

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Foundation for Data Science and Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Data Science and Visualization Lab

COURSE CODE: XXX COURSE CREDITS: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2

Pre-requisite: Python/ R Programming and Machine Learning

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into a usable and desired form	Usage
CO-4	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-5	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage
CO-6	Using data visualization to easily access the huge amount of data in visuals	Usage

List of Experiments

S No	Description	Hours
1	Write a Python/R program to create a vector of a specified type and length. Create a vector of numeric, complex, logical, and character types of length 6. Write a Python/R program to add two vectors of integer type and length 3. Write a Python/R program to create a list containing a vector, a matrix, and a list and remove the second element Write a Python/R program to create a list containing a vector, a matrix, and a list and update the last element.	**2**
2	Write Python/R programs to solve the following tasks in both of them. Read numbers from a file, and print them out in sorted order. Read a text file, and count the total number of words. Read a text file, and count the total number of distinct words. Read a file of numbers, and plot a frequency histogram of them	**2**
3	**Statistical Data Analysis**	**2**

Write a program to solve linear regression for a given data set.

$Y = ax + b$ where

$a = (n\Sigma xy - \Sigma x\Sigma y) / n\Sigma x^2 - \Sigma(x)^2$

$b = (\Sigma y - a\Sigma x)/n$

Here

Y: response variable X: predicator variable

a, b: regression coefficients Read data set

X	Y
-2	-1
1	1
3	2

4

Statistical Data Analysis

Solve the linear regression for a given data set, and also predict sales in the year 2012.

Year	Sales
2005	12
2006	19
2007	29
2008	37
2009	45

2

5

Statistical Data Analysis

Compute Logistic Regression for Organization dataset.

Response Variables

Y = Compensation in rupees Prediction Variables

X_1 = Experience in years

X_2 = Education in years (after 10^{th} standard) X_3 = Number of Employees Supervised

X_4 = Number of Projects Handled

S No	Compensation	Experience	Education	Number supervised	Projects
1	1500	2	5	4	10
2	1650	3	6	5	10
3	1750	3	3	5	12
4	1400	2	3	3	9
5	2000	4	4	6	15
6	2200	5	6	6	14
7	2100	1	5	4	12
8	2750	5	8	7	15
9	2900	8	9	8	25
10	1100	3	3	2	7
11	1000	4	2	1	5
12	1350	6	4	4	12
13	1550	4	6	4	11

2

	Here you will get an error as y- value must be $0 < 1$. So modify Y values.	
6	**Statistical Data Analysis** In an entrance examination, there are twenty multiple-choice questions. Each question has four options, and only one of them is correct. Find the probability of having seven or less than seven correct answers if a student attempts to answer every question at random. Let us assume that the test scores an entrance exam fit a normal distribution where the mean test score is 67, and the standard deviation is 13.7. Calculate the percentage of students scoring 80 or more in the exam?	**2**
Mid-Semester Lab Examination		**2**
7	**Linear Algebra** Compare the speed of a library function for matrix multiplication to your implementation of the nested loops algorithm. How much faster is the library on products of random $n \times n$ matrices, as a function of n as n gets large? What about the product of an $n \times m$ and $m \times n$ matrix, where $n \times m$? By how much do you improve the performance of your implementation to calculate $C = A \times B$ by first transposing **B** internally, so all dot products are computed along rows of the matrices to improve cache performance?	**2**
8	**Linear Algebra** Implement Gaussian elimination for solving systems of equations, $C \times X = Y$. Compare your implementation against a popular library routine for: Speed: How does the run time compare, for both dense and sparse coefficient matrices? Accuracy: What is the size of the numerical residuals $CX - Y$, particularly as the condition number of the matrix increases. Stability: Does your program crash on a singular matrix? What about almost singular matrices, created by adding a little random noise to a singular matrix?	**2**
9	**Data Visualization** Construct a revealing visualization of some aspect of your favorite data set, using: A well-designed table. A dot and/or line plot. A scatter plot. A heatmap. A bar plot or pie chart. A histogram. A data map.	**2**
10	**Data Visualization** Create ten different versions of line charts for a particular set of (x, y) points. Which ones are best and which ones worst? Explain why.	**2**
11	**Data Visualization**	**2**

	Construct scatter plots for sets of 10, 100, 1000, and 10,000 points. Experiment with the point size to find the most revealing value for each data set.	
12	**Data Visualization** Experiment with different color scales to construct scatter plots for a particular set of (x, y, z) points, where color is used to represent the z dimension. Which color schemes work best? Which are the worst? Explain why.	**2**
End-Semester Lab Examination		**2**
	Total Lab hours	**28**

Suggested Text Books:

- Python Data Science Hand Book Jake VanderPlas
- Mastering Python for Data Science - by Samir Madhavan.
- R Programming for Data Science by Roger D. Peng

Reference Books:

- Python Data Science: Hands-on Learning for Beginners Kindle Edition by Travis Booth (Author)
- Data Science with R: A Step By Step Guide with Visual Illustrations & Examples by Andrew Oleksy
- R for Data Science: Import, Tidy, Transform, Visualize, and Model Data by Hadley Wickham (Author), Garrett Grolemund

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Data Science and Visualization Lab)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Computational Data Analysis

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0

Pre-requisite: Basics of probability and statistics

Course Objectives:

1. To provide students with the foundational knowledge of topics such as probability and statistics and algorithms to solve data analysis problems arising in practical applications,
2. To enable students to effectively apply computational methods to solve exemplar data analysis problems arising in relevant applications.
3. Have a good understanding of the fundamental issues and challenges of machine learning.
4. Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
5. Be able to design and implement various machine learning algorithms in a range of real-world applications.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in statistics used in machine learning	Familiarity
CO-2	To understand the concepts associated with the classification and experimental evaluation of classification algorithms	Familiarity
CO-3	To learn about clustering and unsupervised learning	Assessment
CO-4	To learn about various techniques for selecting relevant features selection.	Assessment
CO-5	To learn about various techniques for enhancing the performance of basic machine learning algorithms.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Supervised Learning, Discriminative Algorithms: Supervised Learning Concept, Linear Regression, Maximum Likelihood, Normal Equation, Gradient Descent, Stochastic Gradient, SVRG. Linear Classification, Logistic Regression.	**5**
2	Generative Algorithms: Multivariate Normal, Linear Discriminant Analysis, Naive Bayes,	**5**

	Laplacian Smoothing, Multiclass Classification, K-NN Multi-class Fisher Discriminant Analysis, Multinomial Regression Support Vector Machines and Kernel Methods: Intuition, Geometric Margins, Optimal Margin Classifier, Multiclass SVM	
3	Unsupervised Learning: EM Algorithm, DBSCAN, k-means, Hierarchical clustering	**4**
4	Regularization, Model Selection, and Optimization: Cross-Validation, Bayesian Optimization Bayesian Regression, Bayesian Logistic Regression Forward and Backward Regression, Lasso, elastic-net. Proximal Gradient, Prox-SVRG. Coordinate Proximal Gradient, Pathwise Coordinate Descent	**5**
5	Feature Selection: Information Gain, Correlation Coefficient, Chi-square test, PCA	**4**
6	Ensemble Learning: Bagging, Boosting, Stacking, Entropy, Building Tree, Bagging features, Bagging Samples, Random Forest, Adaboost, Gradient Tree Boosting	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
- Introduction to Machine Learning Edition 2, by Ethem Alpaydin.
- T. Hastie, R. Tibshirani, & J. H. Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer Verlag, 2001.

Suggested Reference Book(s):

- The Elements of Statistical Learning, 2nd Edition, Hastie, Tibshirani and Friedman.
- Foundations of Machine Learning, Mohri, Rostamizadeh and Talwalker
- Richard o. Duda, Peter E. Hart, and David G. Stork, "Pattern Classification", John Wiley Asia, 2006

Other useful resources (s):

- Link to NPTEL course contents: https://nptel.ac.in/courses/106106139/
- https://nptel.ac.in/courses/110106064/

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computational Data Analysis)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	1	2	2	1	3	2	1	1	1	1	1	1	1.4
Average	1.8	2.4	2.4	2.2	2.6	1.2	1	1	1.8	2	1.4	1.8	1.8

Computational Data Analysis Lab

COURSE CODE: XXXXXXXX COURSE CREDITS: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2
Pre-requisite: Python Programming Language

Course Objectives:

1. To develop students' skills in software development techniques using one or more high- level programming languages relevant to data analytics.
2. To enable students to effectively apply computational methods to solve exemplar data analysis problems arising in relevant applications.
3. To learn the implementation of classification techniques for any dataset.
4. To conduct experiments for clustering techniques for any dataset.
5. To discuss different classification and clustering algorithms based on the analysis of results obtained from the experimental evaluation.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	To learn and implement the basic concepts and terminology in statistics used in machine learning	Usage
CO2	To implement classification and clustering algorithms in python	Usage
CO3	To implement feature selection methods in Python	Usage
CO4	To compare different algorithms based on some common factors	Assessment

List of Experiments

S No	Description	Hours
1	Visualize data using any plotting framework How to upload a dataset How to retrieve rows and data in the dataset How to delete a certain column in the dataset How to display minimum, maximum value of a particular feature How to display certain rows of a dataset	**2**
2	Visualize data using any plotting framework How to display certain rows of a dataset How to insert a new row at a particular index Visualization of the dataset (scatterplot, histogram) To find the sum of null values in each column Extracting certain columns	**2**
3	Implement SVM using different kernel methods like Gaussian Radial Basis Function (RBF), Laplace RBF kernel, ANOVA Radial Basis kernel,	**2**

	Polynomial Kernel.	
4	Implement Naïve Bayes using Bernoulli model and Multinomial model (Laplace smoothing and Log-Transformation).	**2**
5	Implement K-NN and DT	**2**
6	Implement Linear regression and Logistic regression	**2**
7	Implement the following clustering techniques: K-means, *Hierarchical,*	**2**
8	Implement the following clustering techniques: *DBSCAN,* EM Algorithm	**2**
9	Implement various feature selection methods Information Gain Correlation Coefficient	**2**
10	Implement various feature selection methods Chi-square test PCA	**2**
11	Implement the following ensemble techniques: XGBoost, AdaBoost	**2**
12	Implement the following ensemble techniques: Gradient Boosting, Bagging	**4**
	Total Lab hours	**28**

Suggested/Resources:

- Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
- Sebastian Raschka, "Python Machine Learning", Packt Publishing Ltd.
- Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly Media, Inc.
- Sunila Gollapudi, "Practical Machine Learning", Packt Publishing Ltd
- Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, Inc.
- Willi Richert, "Building Machine Learning Systems with Python", Packt Publishing Ltd.

Link to topics related to course:

- https://www.python-course.eu/machine_learning.php
- https://www.analyticsvidhya.com/blog/2018/05/24-ultimate-data-science-projects-to- boost-your knowledge-and-skills/
- https://www.datacamp.com/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	10 Marks
4	Project	20 Marks
5	Lab Assessment	30 Marks
	Total	**100 marks**

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	1.8
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	2.3
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	2.3
CO-4	3	3	3	3	3	2	1	2	2	1	2	3	2.3
Average	3	2.8	2.5	2.8	3	1.8	1	1.8	1.8	1	2	2.8	2.2

Big Data and Hadoop

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. Understand the fundamentals of Concepts in BigData and Hadoop etc
2. Understand the fundamentals of Hadoop etc.
3. Be able to use the HDFS file system, debug and run simple Java programs for HDFS.
4. Be aware of the important topics and principles of software development and write better &more maintainable code
5. Be able to program using advanced Java topics like JDBC, Servlets, and JSP.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	What is big data: introduction to the data lake, why do companies care for big data, why do we out of big data, social media	Familiarity
CO-2	History of Hadoop, the importance of HDFS: Hadoop timeline, why Hadoop, Hadoop 1.x architecture, core components, and job process	Assessment
CO-3	Different phases in Map Reduce: input-output formats in each phase, modeling real-world applications in map-reduce, understanding map-reduce program execution, problems in map-reduce	Assessment
CO-4	Apache Hive, Apache PIG: introduction to Hive meta store, SQL vs Hive, Hive query language, managed and external tables, querying data, introduction to PIG, map-reduce vs PIG, PIG in local mode, PIG in the map-reduce mode	Usage
CO-5	SQOOP: Introduction to SQOOP framework, SQOOP flavors of import, SQOOP flavors of export, SQOOP CLI options	Usage
CO-6	FLUME: Introduction to messaging service, applications of a messaging service, FLUME architecture framework, working of a FLUME agent, understanding FLUME configurations, Hadoop ecosystem labs, importing data from MYSQL and querying it using HIVE, configuring FLUME agent to listen to local log files	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	What is big data: introduction to the data lake, why do companies care for big data, why do we out of big data, social media	4
2	History of Hadoop, the importance of HDFS: Hadoop timeline, why Hadoop, Hadoop 1.x architecture, core components, and job process	4
3	Different phases in Map Reduce: input-output formats in each phase, modeling real-world applications in map-reduce, understanding map-reduce program execution, problems in map-reduce	5
4	Apache Hive, Apache PIG: introduction to Hive meta store, SQL vs Hive, Hive query language, managed and external tables, querying data, introduction to PIG, map-reduce vs PIG, PIG in local mode, PIG in a map-reduce mode	4
5	SQOOP: Introduction to SQOOP framework, SQOOP flavors of import, SQOOP flavors of export, SQOOP CLI options	6
6	FLUME: Introduction to messaging service, applications of a messaging service, FLUME architecture framework, working of a FLUME agent, understanding FLUME configurations, Hadoop ecosystem labs, importing data from MYSQL and querying it using HIVE, configuring FLUME agent to listen to local log files	5
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Big Data and Hadoop, V.K. Jain (https://books.google.co.in/books?id=i6NODQAAQBAJ&printsec=frontcover&redir_esc=y#v=onepage&q&f=false).
- Big Data and Hadoop, MAYANK BHUSHAN**. Other useful resources (s):**

- https://www.youtube.com/watch?v=1vbXmCrkT3Y

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Big Data and Hadoop)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
CO-5	2	3	1	1	2	3	2	1	2	3	3	2	**2.1**
CO-6	2	3	3	2	1	3	2	2	3	3	2	2	**2.3**
Average	**2**	**2.7**	**2.3**	**2.2**	**2.2**	**1.7**	**1.3**	**1.2**	**2.2**	**2.5**	**1.8**	**2**	**2**

Big Data and Hadoop Lab

COURSE CODE: XXXXXXXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2

Pre-requisites: An understanding in practicalities of big data and Hadoop to any programming language (Preferably, C)

Course Objective

The lab course provides a complete description of the inner working of big data and Hadoop. The main focus is on the design of big data techniques. The course also aims to convey the language specifications, use of file management tasks, and map-reduce behind the design of algorithms. It builds an understanding of various techniques like map-reduce, pig Latin scripts, etc.

Course Outcomes (COs):

S No	Course outcomes	Level of Attainment
CO-1	Perform setting up and Installing Hadoop in various operating modes	Familiarity
CO-2	Implement file management tasks in Hadoop	Familiarity
CO-3	Running a Map-Reduce Paradigm	Computational skills
CO-4	Run Pig then write Pig Latin scripts	Technical skills

List of Experiments

S No	Topic	Hours
1	Implement the following data structures in Java: Linked list, stacks, queues, Set and Map	**2**
2	Perform setting up and Installing Hadoop in its three operating modes: Standalone, Pseudo distributed, Fully distributed Use web-based tools to monitor your Hadoop setup.	**4**
3	Implement the following file management tasks in Hadoop: Adding files and directories Retrieving files Deleting files Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command-line utilities.	**4**

4	Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm	**4**
5	Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce since it is semi-structured and record-oriented	**4**
6	Implement Matrix Multiplication with Hadoop Map Reduce	**2**
7	Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data	**4**
8	Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
	Total		**100**

Reference Books:

- Big Data and Hadoop, V.K. Jain
- Big Data and Hadoop, MAYANK BHUSHAN

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	1	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	2	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	2	2	2	2	2	1	2	3	3	2	2.3
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	2.3
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	2.2	1.8	1.4	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Computability, Complexity, and Algorithms

COURSE NAME: Computability, Complexity and Algorithms COURSE CODE: XXXXXXXX
COURSE CREDITS: 3 CORE/ELECTIVE: ELECTIVE L-T-P: 3-0-0
Pre-requisite: None

Course Objectives:

1. Learn to analyze algorithms for Time and Space Complexity
2. Learn asymptotic notations for performance analysis of algorithms.
3. Learn various computational and complexity of randomizedalgorithms.
4. Apply important algorithmic design paradigms and methods of analysis.
5. Synthesize efficient mathematical induction and asymptotic notations.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction of algorithms	Familiarity
CO-2	Demonstrate familiarity with major topics of algorithm analysis.	Assessment
CO-3	Introduction of computability theory.	Assessment
CO-4	Analysis of time complexity of randomized algorithms.	Usage
CO-5	An introduction of probability and randomized algorithms	Usage
CO-6	A brief description of probability, mathematical induction, and asymptotic notations	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to algorithm analysis:** Basic introduction of algorithms, divide and conquer paradigm, Asymptotic notations, Probabilistic and randomized algorithms.	7
2	**Advanced algorithm I:** Dynamic programming, Greedy algorithms, and amortized analysis.	7
3	**Advanced topics in algorithms II:** Graph algorithm, flow in networks, bipartite matching's.	6
4	**Computability Theory:** Turing machines, decidability, mapping reducibility	6
5	**Complexity Theory:** Introduction to time complexity, NP and NP-completeness, Approximation algorithms, and derandomization.	7
6	**Probabilistic and Randomized Algorithms:** Probabilistic algorithms; Randomizing deterministic algorithms, Monte Carlo and	6

	Las Vegas algorithms; Probabilistic numeric Algorithms.	
7	**Supplementary material: Mathematical induction, asymptotic notations, and probability**	**3**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- V. J. Rayward-Smith, *A first course in computability,* McGraw Hill, 1995? An introductory paperback that covers Parts I and III of the course, and some of Part II. More detailed than this course.

- D. Harel, *The Science of Computing,* Addison-Wesley, 1989. A good book for background and motivation, with fair coverage of this course and a great deal more. Some may find the style diffuse. Less detailed than this course

Suggested Reference Book(s):

- Robert Sedgewick, *Algorithms,* Addison-Wesley, 2nd ed., 1988. A practical guide to many useful algorithms and their implementation. A reference for Part II of the course.
- J. Bell, M. Machover, *A course in mathematical logic,* North-Holland, 1977. A good mathematical text, for those who wish to read beyond the course.
- G. Boolos, R. Jeffrey, *Computability and Logic,* Cambridge University Press, 1974

Other useful resources (s):

- youtube.com/playlist?list=PLLkyyG3XCR1mCH_XAWGdm9u4h_VTIRYC-

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computability, Complexity, and Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	1	1	2	3	2	1	2	3	3	2	2.1
CO-6	2	3	3	2	1	3	2	2	3	3	2	2	2.3
Average	2	2.7	2.3	2.2	2.2	1.7	1.3	1.2	2.2	2.5	1.8	2	2

Course Outcomes (COs) contribution to PSOs

Attainment of PSOs through COs					
Sr. No.	PSO-1	PSO-2	PSO-3	PSO-4	Average
CO-1	3	2	2	1	2
CO-2	3	3	2	2	2.5
CO-3	3	2	3	2	2.5
CO-4	3	3	2	3	2.8
CO-5	3	2	2	1	2
CO-6	3	2	1	2	2
Average Score	3	2.3	2	1.8	

Computability, Complexity and Algorithms Lab

Course Code: XXXXXXX
Course Title: Computability, Complexity and Algorithms Lab
Course Credits: 01
CORE/ELECTIVE: ELECTIVE
Semester: VIIIth Semester
: 0-0-2

Pre-requisites: An understanding in practicalities of Computability, Complexity, and Algorithms to any programming language (Preferably, C)

Course Objective
The lab course provides a complete description of the inner working of complexity and algorithms. The main focus is on the design of algorithms and computational techniques. The course also aims to convey the language specifications, use of regular expressions, and computations behind the design of algorithms.
Course Outcome (CO)

S No	Course outcomes	Level of Attainment
CO-1	Construction of dynamic and greedy algorithms	Familiarity
CO-2	Analyzing the *t*ime complexity of graph, dynamic and greedy methods	Familiarity
CO-3	Construction of minimization of automata	putational skills
CO-4	Building various probabilistic techniques	Technical skills

List of Practical

S. No	Topic	Hours
1	Write a program to read and translate integers into numbers. e.g. 1=ONE, 12 = ONE TWO and 856 = EIGHT FIVE SIX, Generate an error if the number of digits is more than 3	**2**
2	Write a program to convert infix notation to postfix notation.	**2**
3	Implement a DFA which simulates the regular expression a + (aa)*b.	**4**
4	Write a program to implement minimization of finite automata	
5	Implementation of greedy algorithms	**4**
6	Implementation of dynamic programming algorithms	
7	Program for computation of computability and complexity theory.	**4**
8	Write a program to check advanced algorithms like dynamic programming, greedy algorithm.	**4**
9	Implementation of an approximation algorithm	**4**
10	Implementation of a randomized algorithm	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Booka

- V. J. Rayward-Smith, *A first course in computability,* McGraw Hill, 1995? An introductory paperback that covers Parts I and III of the course, and some of Part II. More detailed than this course.
- D. Harel, *The Science of Computing,* Addison-Wesley, 1989. A good book for background and motivation, with fair coverage of this course and a great deal more. Some may find the style diffuse. Less detailed than this course

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	1	1	2	2	2	1	2	3	3	2	2.1
CO-4	3	3	2	2	2	2	3	2	2	1	2	2	2.2
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	1.8	1.2	1.6	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Course Outcomes (COs) contribution to PSOs

Attainment of PSOs through COs					
Sr. No.	PSO-1	PSO-2	PSO-3	PSO-4	Average
CO-1	3	2	2	1	2
CO-2	3	3	2	2	2.5
CO-3	3	2	3	2	2.5
CO-4	3	3	2	3	2.8
CO-5	3	2	2	1	2
CO-6	3	2	1	2	2
Average Score	3	2.3	2	1.8	

Computer and Robot Vision

Course Name: Computer and Robot Vision
Course Code: XXXXX
Course Credits: 3 CORE/ELECTIVE: ELECTIVE L-T-P: 3-0-0
Pre-requisite: Image Processing and Robotics

Course Objectives:

1. To learn fundamental image processing techniques required for computer vision.
2. To learn shape analysis and boundary tracking.
3. To learn and apply chain codes and other region descriptors.
4. To learn and apply the Hough Transform for line, circle, and ellipse detections.
5. To learn and apply 3D vision techniques, implement motion-related techniques, and Develop applications using computer vision techniques.

Course outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Implement fundamental image processing techniques required for computer vision	Familiarity
CO-2	Perform shape analysis and implement boundary tracking techniques	Usage
CO-3	Apply chain codes and other region descriptors.	Usage
CO-4	Apply Hough Transform for line, circle, and ellipse detections	Usage
CO-5	Apply 3D vision techniques, implement motion-related techniques, and Develop applications using computer vision techniques	Usage

Detailed Course Contents:

Unit	Contents	Lectures required
1	**CAMERAS:** Pinhole Cameras, **Radiometry – Measuring Light:** Light in Space, Light Surfaces, Important Special Cases, **Sources, Shadows, And Shading:** Qualitative Radiometry, Sources, and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models, **Color:** The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.	8
2	**Linear Filters:** Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency, and Fourier Transforms, Sampling, and Aliasing, Filters as Templates, **Edge Detection:** Noise, Estimating Derivatives, Detecting Edges, **Texture:** Representing Texture, Analysis (and Synthesis) Using Oriented	8

	Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture.	
3	**The Geometry of Multiple Views:** Two Views, **Stereopsis:** Reconstruction, Human Stereposis, Binocular Fusion, Using More Cameras, **Segmentation by Clustering:** What Is Segmentation?, Human Vision: Grouping and Gestalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering,	**8**
4	**Segmentation by Fitting a Model:** The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness, **Segmentation and Fitting Using Probabilistic Methods:** Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice, **Tracking With Linear Dynamic Models:** Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications, and Examples.	**8**
5	**Geometric Camera Models:** Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations, **Geometric Camera Calibration:** Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, An Application: Mobile Robot Localization, **Model-Based Vision:** Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Application: Registration In Medical Imaging Systems, Curved Surfaces, and Alignment.	**10**
	Total Lecture Hours	**42**

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered upto T- 1
2	Test -2	25	1 hr 30 min.	Syllabus covered upto T- 2
3	Test - 3	35	2 hours	Full Syllabus
4	Regularity, ssignments, Quizzes.	25	Entire Semester	Regularity- 4 Assignments - 9 Quizzes - 12

Text Books:

- David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

- E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs	O- 1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO- 10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-2	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-3	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-4	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-5	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-6	3	2	2	3	3	3	3	2	3	2	3	3	2.7
Average	3	2.8	2.8	3	2.2	3	3	2	3	2	3	3	2.7

Computer and Robot Vision Lab

Course Name: Computer and Robot Vision Lab
Course Code: xxx
Course Credits: 01 **CORE/ELECTIVE:** ELECTIVE L-T-P: 0-0-2
Pre-requisites: Image Processing and Artificial Intelligence

Objective: The main target of computer vision is the 3-D world. Most computer vision algorithms require some form of image processing. Robot vision is to program a **robot** to "see" through a camera either mounted on the **robot**, or in a static position, takes pictures of each workpiece that the **robot** will interact with. This course integrates the two disciplines to achieve a significant purpose.

Course Outcomes (COs)

S No	Course outcomes	Level of Attainment
CO 1	To study cameras, radiometry, sources, and properties.	Familiarity
CO 2	To understand and implement linear filters, edge detection, and texture.	Usage
CO 3	To understand and implement the Geometry of Multiple Views, Stereopsis, and Segmentation by Clustering.	Usage
CO 4	To understand and implement Segmentation by Fitting a Model, Segmentation and Fitting Using Probabilistic Methods, and Tracking With Linear Dynamic Models.	Usage
CO 5	To understand and implement Geometric Camera Models and Geometric Camera Calibration.	Usage

List of experiments

S No	Topic	Hours
1	Pinhole Cameras, Radiometry – Measuring Light, Sources, Shadows, And Shading, Color	6
2	Linear Filters, Edge detection, and Texture	6
3	The Geometry of Multiple Views, Stereopsis, and Segmentation by Clustering	6
4	Segmentation by Fitting a Model, Segmentation and Fitting Using Probabilistic Methods, and Tracking With Linear Dynamic Models	6
5	Geometric Camera Models and Geometric Camera Calibration	4
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Text Books:

- David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

- E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	1	1	2	1	1	3	2.1
CO-2	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-3	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-4	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-5	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-6	3	3	3	3	3	3	1	1	2	1	1	3	2.3
Average	3	3	3	2.8	2.8	3	1	1	2	1	1	3	2.2

Human-Computer Interaction

Course Name: Human-Computer Interaction
Course Code: XXXXX
Course Credits: 2-0-0 CORE/ELECTIVE: ELECTIVE L-T-P: 3-0-0
Pre-requisite: Image Processing and Robotics

Course Objectives:

- Design, implement, and evaluate effective and usable graphical computer interfaces.
- Describe and apply core theories, models, and methodologies from the field of HCI.
- Describe and discuss current research in the field of HCI.
- Implement simple graphical user interfaces using the Java Swing toolkit.
- Describe special considerations in designing user interfaces for older adults.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To learn to explain why it is important to design interactive products that are usable, define key terms used in interaction design	Familiarity
CO-2	To learn to explain key theories used in the design of interactive products and to explain the importance of iteration, evaluation, and prototyping in interaction design	Familiarity
CO-3	To gather data in the context of developing a simple interactive product using suitable techniques	Technical Skills
CO-4	To produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles and to evaluate an interactive product using suitable techniques	Technical Skills
CO-5	To communicate effectively to peers and specialists about requirements, design, and evaluation activities relating to interactive products	Key Skills
CO-6	To define a suitable program of user involvement that treats users ethically and fairly.	Key Skills

Course Contents:
:

Unit	Topic	Lectures required
1	Principles of HCI : History and Foundations of HCI, Research Frameworks in HCI, Modeling Social and Emotional Processes, Computer-Mediated Communication, Social and Embodied Interfaces I, II, Computer-Supported	4

	Collaborative Work	
2	Principles of HCI : Speech Interfaces, Games, Crowdsourcing, Information Visualization, Ubiquitous Computing, Assistive and Accessible Interfaces, Future of HCI	7
3	Human Subjects Research Methods: Introduction: Research methods in HCI, Introduction: What are elements of a research project in HCI?, Introduction: How to choose research designs?, Introduction: Methodological fit, Qualitative research: data collection, Qualitative research: data analysis	5
4	Quantitative research: Experimental design principles, Quantitative research: Step-by-step experimental design, Quantitative research: Measurement, Part I, Quantitative research: Measurement, Part II, Quantitative research: Measurement, Part III, Quantitative research: Scale construction, Quantitative research: Statistics, Part I, Quantitative research: Statistics, Part II, Quantitative research: Statistics, Part III	8
5	**Project:** Completing the required human-subjects research training program and an Institutional Review Board (IRB) application for the project, Gaining a theoretical and empirical understanding of the application domain, Applying exploratory and experimental research methods in HCI	2
6	Prototyping user interfaces, Designing exploratory and experimental studies, Gaining experience in recruiting participants, and conducting studies with human subjects, Creating generalizable knowledge on how computing can improve aspects of human life.	2
	Total Lecture Hours	28

Evaluation Scheme

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered up to T- 1
2	Test -2	25	1 hr 30 min.	Syllabus covered up to T- 2
3	Test - 3	35	2 hours	Full Syllabus
4	Regularity, Assignments, Quizzes.	25	Entire Semester	Regularity- 4 Assignments - 9 Quizzes - 12

Reference Books:

- Interaction the BCS Specialist Group on Interaction
- The Usability Professionals' Association (UPA) - founded in the US, with local chapters in the US and other countries
- Mikael Ericsson's listing of research labs and projects worldwide
- Ubiquity - ACM online magazine (general IT topics, but lots relevant to HCI)
- Alan's column and resources on HCI Education in SIGCHI Bulletin
- HCI International has a bi-monthly subscription newsletter partly about the conference,but also carrying general news, events, etc. back issues at their Press Room

- Videos in User-System Interaction - collated by Matthias Rauterberg
- The HCI Bibliography - free-access online bibliographic database on Human-Computer Interaction
- HCI Resource Network - event listings, links, jobs, and subscription-only sections, includes A-Z of HCI topics
- Hans de Graaff's HCI Index
- Craig Marion's Software Design Smorgasbord
- Gary Perlman's Resources in HCI columns from Interactions
- University of Michigan HCI resource links
- The Usability First web site has good collections of resources, particularly for web and accessibility
- Usability First glossary of usability terms
- CHI recently completed theses list
- ComputingCases.org a resource site for teaching ethical issues in computing
- SAP Usability Glossary

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Sr No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	2	2	1	2	3	3	2	1	1	1	3	2
CO-2	3	3	3	2	1	1	1	3	2	1	1	3	2
CO-3	3	3	2	3	2	1	1	2	2	1	1	2	1.9
CO-4	3	3	3	3	2	1	1	3	2	1	1	2	2.1
CO-5	3	3	3	3	2	1	1	3	2	1	1	3	2.2
CO-6	3	3	3	3	2	1	1	3	2	1	1	3	2.2
Avg	3	2.8	2.7	2.5	1.8	1.3	1.3	2.7	1.8	1	1	2.7	2.1

Human-Computer Interaction Lab

Course Name: Human-Computer Interaction Lab Course Code: XXXXX
Course Credits: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2

Pre-requisite: Image Processing and Robotics Course Objective:

This course provides an introduction to and overview of the field of human-computer interaction (HCI). HCI is an interdisciplinary field that integrates theories and methodologies from computer science, cognitive psychology, design, and many other areas. Course readings will span current theory and practice in interface specification, design and evaluation, as well as current and classic research papers in HCI. Students will work on both individual and team projects to design, implement and evaluate computer interfaces. The course is open to students from all disciplines, providing them with experience working in interdisciplinary design teams. Lab course of two hours per week will supplement the theory. Implementation of basic and advanced algorithms will be done with C/C++. Basic knowledge of C/C++ programming is mandatory.

The course will involve four hours of contact including lectures, tutorials and lab classes. Students are strongly encouraged to participate actively in class discussions.

Course Outcomes (COs)

S No	Course outcomes	Level of Attainment
CO 1	To design interactive products that are usable, define key terms used in interaction design, explain key theories used in the design of interactive products.	Familiarity
CO 2	To explain the importance of iteration, evaluation, and prototyping in interaction design.	Usage
CO 3	To gather data in the context of developing a simple interactive product using suitable techniques, produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles.	Usage
CO 4	To evaluate an interactive product using suitable techniques.	Usage
CO 5	To define a suitable program of user involvement that treats users ethically and fairly.	Usage

List of Experiments

S No	Topics	Hours
1	Getting familiar with Visual Studio Multiplication and Addition of any two numbers	**2**
2	Design an user interface for assigning a grade to students based on the subjects marks Design user interface for printing the numbers in Ascending order Descending order Subtraction	**2**
3	Design an user interface for calculator Design an user interface for registration of a student for admissions.	**2**
4	Design an user interface for semester registration Design an user interface for displaying and changing of a picture on the form Design an user interface for To count the number of digits in a given number	**2**
5	Design an user interface for simple sort program Design user interface	**2**
6	User interest form Making suggestion form	**2**
7	Design an user interface to check whether the year is a leap year or not Design an user interface for menu-based program	**2**
8	Design user Interfaces for ATM Machine Design user Interfaces for Socio E-commerce shop	**2**
9	Design user Interfaces for SmartPhone Design user Interfaces for Railway Reservation System	**4**
10	Design user Interfaces for Online Examination Design user Interfaces for Hospital management	**4**
11	Design user Interfaces for library management Design and User Interfaces for Hotel Booking	**4**
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Books:

- Interaction the BCS Specialist Group on Interaction
- The Usability Professionals' Association (UPA) - founded in the US, with local chapters in the US and other countries
- Mikael Ericsson's listing of research labs and projects worldwide
- Ubiquity - ACM online magazine (general IT topics, but lots relevant to HCI)
- Alan's column and resources on HCI Education in SIGCHI Bulletin
- HCI International has a bi-monthly subscription newsletter partly about the conference, but also carrying general news, events, etc. back issues at their Press Room
- Videos in User-System Interaction - collated by Matthias Rauterberg
- The HCI Bibliography - free-access online bibliographic database on Human-Computer Interaction
- HCI Resource Network - event listings, links, jobs, and subscription-only sections, includes A-Z of HCI topics
- Hans de Graaff's HCI Index
- Craig Marion's Software Design Smorgasbord
- Gary Perlman's Resources in HCI columns from Interactions
- University of Michigan HCI resource links
- The Usability First web site has good collections of resources, particularly for web and accessability
- Usability First glossary of usability terms

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	3	3	2	2	3	1	1	2	1	1	3	2.1
CO-2	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-3	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-4	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-5	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-6	3	3	3	3	3	3	1	1	2	1	1	3	2.3
Avg	3	3	3	2.8	2.8	3	1	1	2	1	1	3	2.2

Cloud Computing: Concepts, Technology & Architecture

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0

Pre-requisite: Knowledge of Computer Architecture, Computer Networking, and Distributed Computing.

Course Objectives:

1. To demonstrate an understanding of cloud computing concepts and standards.
2. To understand all enabling technologies of Cloud computing.
3. To discuss issues and challenges about the management of emerging cloud computing technologies and learn approaches to manage them.
4. To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts, applications, and terminology of cloud computing.	Familiarity
CO-2	To learn basic concepts of infrastructure management and load balancing.	Familiarity
CO-3	To learn basic concepts of cloud security and metrics for evaluation.	Assessment
CO-4	To understand cloud computing and its role in new distributed computing implementation.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Understanding Cloud Computing:** Basic Concepts and terminology, Goals and Benefits Risks and Challenges, Roles and boundaries, Cloud characteristics Cluster Computing, Grid Computing NIST Architecture, Cloud Deployment models Cloud service models	**4**
2	**Cloud Enabling Technologies:** Virtualization, Types of virtualization, Server Consolidation, virtualization management Web Technology Service-Oriented Architecture Datacenter and Multi-tenancy	**4**

3	**Cloud Infrastructure Management:** Cloud datacenter design, Workloads and software infrastructure for a datacenter Datacenter hardware, energy and power efficiency in a datacenter Cloud usage monitor, Monitoring agent, Resource agent, Polling Agent	**4**
4	**Cloud Mechanisms:** Automated Scaling Load Balancer SLA Monitor Failover System Multi-Cloud Broker	**5**
5	**Load Management:** Fundamental Cloud Architectures: workload distribution architecture, resource pooling architecture, dynamic scalability architecture, service load balancing architecture, cloud bursting architecture Billing Management System Business cost metrics, cloud usage cost metrics	**6**
6	**Metrics & security:** Cloud service metrics Cloud Security Mobile cloud computing Disaster recovery in cloud computing Case studies	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568.
- Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.

Suggested Reference Book(s):

- Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter; Tata McGraw – Hill Edition
- The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers
- Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
- The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos.

Other useful resources (s):

- Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
- Link to topics related to course:
- **https://www.edx.org/learn/cloud-computing**

- **https://www.udemy.com/introduction-to-cloud-computing/**
    - **https://nptel.ac.in/courses/106104019/2 Evaluation Scheme**

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs):

Course outcomes ((Cloud Computing: Concepts, Technology & Architecture)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Cloud Computing: Concepts, Technology & Architecture Lab

COURSE CODE: XXXXXXXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2

Pre-requisite: Knowledge of Visualization, Web Service Architecture, Computer Architecture, Computer Networking, and Distributed Computing.

Course Objectives:

- To demonstrate various Visualization Platform.
- To demonstrate an understanding of cloud computing concepts and standards.
- To understand all enabling technologies for Cloud Deployment.
- To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	To learn the basic concepts, applications, and terminology of cloud computing.	Familiarity
CO2	To learn basic concepts of infrastructure management and load balancing.	Familiarity
CO3	To learn basic concepts of cloud security and metrics for evaluation.	Assessment
CO4	To understand cloud computing and its role in new distributed computing implementation.	Assessment

List of Experiments:

S No	Description	Hours
1	Introduction to Infrastructure as a Service Platforms like EC2 (AWS). Demonstrate the creation of a computing platform.	**2**
2	Demonstrate management and deployment for the IAAS platform by Remote Access platforms (Putty, remote desktop, etc).	**2**
3	Introduction to Visualization and its various types (Hypervisor type0 and type1).	**2**
4	Implementation of Visualization platforms (Sun Virtual Box, VM workstation, Zen, KVM) for Virtual Machine (VM) creation and management.	**4**
5	Implement and Management of various Virtual disk standards and VM imaging formats for Virtual Machine.	4
6	Implementation and installation of a Cloud management platform like	**4**

	open-stack / Eucalyptus etc.	
7	Creating a Warehouse Application in SalesForce.com.	4
8	Implementation and Deployment of a Platform as a Service Platform like Google App engine/ Microsoft azure etc.	**2**
9	Installation and Configuration of Hadoop.	**2**
10	Introduction to Cloud Simulation Platforms Like CloudSim and Green Cloud.	**2**
	Total Lab hours	**28**

Suggested Reference Books:

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568.
- Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.
- Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter; Tata McGraw – Hill Edition
- The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers
- Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
- The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos.
- Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
- Link to topics related to course:

a. https://www.edx.org/learn/cloud-computing
b. https://www.udemy.com/introduction-to-cloud-computing/
c. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
Average	3	3	2.8	2.8	2.5	2	1.3	1	1	1	1.3	1.5	1.9

Cloud Computing Security

COURSE CODE: XXXXXXXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0

Pre-requisite: None

Course Objectives:

1. Understand some of the major security challenges of cloud computing that act as a hindrance to widespread adoption.
2. Learn about some of the newer techniques that scientists are considering to protect cloud systems, their advantages, and disadvantages.
3. Learn how to critically evaluate security literature.
4. Learn how to formulate and solve a research problem in computer security and be able to present it.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To understand the use of cloud computing	Familiarity
CO-2	A different technique to secure the cloud	Assessment
CO-3	Different types of attacks on the cloud.	Assessment
CO-4	Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud-based IT services	Usage

Course Contents:

Unit	Contents	Lectures required
1	Architectural and Technological Influences of Cloud Computing, Cloud deployment models Public, Private, Community and Hybrid models, Software as a Service (SaaS) Platform as a Service (PaaS) Infrastructure as a Service (IaaS), Cloud Computing Roles, Risks and Security Concerns	**4**
2	Guiding Security design principles for Cloud Computing, Secure Isolation, Comprehensive data protection, End-to-end access control, monitoring and auditing, Quick look at CSA, NIST and ENISA guidelines for Cloud Security, Common attack vectors and threats	**6**
3	**Secure Isolation**, Compute, Network and Storage, Common attack vectors and threats, Secure Isolation Strategies, Multitenancy, Virtualization strategies, Inter-tenant network segmentation	**6**

	strategies, Storage isolation strategies	
4	**Data Protection:** Understand the Cloud-based Information Life Cycle, Data protection for Confidentiality and Integrity, Common attack vectors and threats, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key Management, Assuring data deletion, data retention, deletion and archiving procedures for tenant data, Data Protection Strategies	**6**
5	**Access Control for Cloud:** Understand the access control requirements for Cloud infrastructure, Common attack vectors and threats, Enforcing Access Control Strategies, Compute, Network and Storage, Authentication and Authorization, Roles-based Access Control, Multi-factor authentication, Host, storage and network access control options, OS Hardening and minimization, securing remote access, Verified and measured boot, Firewalls, IDS, IPS and honeypots	**6**
6	**Monitoring and auditing:** Proactive activity monitoring, Incident Response, Monitoring for unauthorized access, malicious traffic, abuse of system privileges, intrusion detection, events and alerts, Auditing – Record generation, Reporting, and Management, Tamper- proofing audit logs, Quality of Services, Secure Management, User management, Identity management, Security Information, and Event Management	**6**
7	**Identity Management in Cloud:** User Identification, Authentication, and Authorization in Cloud Infrastructure, Be able to understand the concepts of Identity & Access Management, Single Sign-on, Identity Federation, Identity providers and service consumers, The role of Identity provisioning	**4**
8	**Technology Review:** OpenStack Platform, Docker, Amazon Web Services	**4**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Cloud Computing Security: Foundations and Challenges John R. Vacca
- Cloud Security: A Comprehensive Guide to Secure Cloud Computing Ronald L Krutz, Russell Dean Vines

Suggested Reference Book(s):

- Securing The Cloud: Cloud Computing Security Techniques and Tactics by Vic (J.R.) Winkler
- Cloud Computing Design Patterns by Thomas Erl (Prentice Hall)

Other useful resources (s):

- http://www.cs.colostate.edu/~cs656/

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Cloud Computing Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Information Security

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: Elective
: 2-0-0

Pre-requisite: None

Course Objectives:

1. Investigation of core security technologies and security policies to mitigate risks.
2. Gain an understanding of network perimeter security design principles
3. Gain an understanding of free/ commercial security tools and their applications and develop the security solution for a given application/scenario.
4. Ability to review procedures for installation, troubleshooting, and monitoring of network devices to maintain integrity, confidentiality, and availability of data and devices.
5. Knowledge of the technologies that underpin the deployment and maintenance of a secure network.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the need for security	Familiarity
CO-2	Analysis of security algorithms	Assessment
CO-3	Demonstrate familiarity with major security algorithms and data structure.	Assessment
CO-4	Apply important security algorithmic design paradigms and methods of analysis.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Symmetric Encryption** Shift Cipher, Substitution Cipher, Vigen`ere Cipher, A Permutation Cipher Introduction To Symmetric Ciphers, Stream Cipher Basics, The Lorenz Cipher, Linear Feedback Shift Registers, Combining LFSRs, RC4	5
2	Introduction To Block Ciphers, Feistel Ciphers and DES, Rijndael, Modes of Operation Key Management, Secret Key Distribution, Formal Approaches to Protocol Checking Hash Functions, Designing Hash Functions, Message Authentication Codes	5

3	**Public Key Encryption and Signatures** Public Key Cryptography Candidate One-way Functions, RSA, ElGamal Encryption, Rabin Encryption, Paillier Encryption Diffie–Hellman Key Exchange, Digital Signature Schemes, The Use of Hash Functions In Signature Schemes, The Digital Signature Algorithm, Schnorr Signatures, Nyberg–Rueppel Signatures	**5**
4	**Attacks on Public-Key Schemes** Wiener's Attack on RSA, Lattices and Lattice Reduction, Lattice-Based Attacks on RSA, Partial Key Exposure Attacks	**5**
5	**Provable Security:** Security of Signature Algorithms, Security of Encryption Algorithms, Hybrid Ciphers, Signature Schemes, Encryption Algorithms	**4**
6	**Advanced Protocols:** Access Structures, General Secret Sharing, Reed–Solomon Codes, Shamir Secret Sharing, Commitment Schemes, Oblivious Transfer, Showing a Graph Isomorphism in Zero-Knowledge, Zero-Knowledge and NP, Sigma Protocols	**4**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cryptography: An Introduction, Nigel Smart
- Cryptography and Network Security: Principles and Practice William Stallings

Suggested Reference Book(s):

- A.J. Menezes, P. van Oorschot, and S.A. Vanstone. The Handbook of Applied Cryptography.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Information Security Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2

Pre-requisite: None

Course Objectives:

1. To understand the basic security algorithms
2. To Implement various symmetric cipher
3. To implement various public-key encryption algorithms

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the basic security services e.g. Authentication, Access Control, Confidentiality, Integrity	Familiarity
CO2	Learn standard symmetric encryption algorithms	Assessment
CO3	Learn architecture for public and private key cryptography.	Assessment
CO4	Learn the methods of digital signature and encryption.	Assessment
CO5	Learn key management and how key exchange protocols work.	Uses
CO6	Learn futuristic cryptographic techniques like Elliptic Curve and quantum cryptography	Assessment

List of Experiments

S No	Description	Hours
1	Study of Network Security fundamentals - Ethical Hacking, Social Engineering practices.	**2**
2	Study of System threat attacks - Denial of Services	**2**
3	Study of Sniffing and Spoofing attacks	**2**
4	Study of Techniques uses for Web-Based Password Capturing	**2**
5	Study of Different attacks causes by Virus and Trojans	**2**
6	Study of Anti-Intrusion Technique – Honey pot	**2**
7	Study of Symmetric Encryption Scheme – RC4	**4**
8	Implementation of S-DES algorithm for data encryption	**4**
9	Implementation of Asymmetric Encryption Scheme – RSA.	**4**
10	Study of IP based Authentication	**4**
	Total Lab hours	**28**

Suggested/Resources:

- Atual Kahate, " Cryptography and Network Security", TMH.
- William Stalling, " Cryptography and Network Security", Pearson.

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Game Development and Design

Course Name: Game Development and Design
Course Code: XXX
Course Credits: 2
CORE/ELECTIVE: ELECTIVE
Prerequisite: Knowledge of programming language (Python, C++,

Course Objective(s): To introduce students to the novel concepts of game development and design with special emphasis on its applications in diverse fields and current research.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Game Theory Introduction with Various Theorem	Familiarity
CO-2	Introduction of Nash Equilibrium, Bounded Rationality, Strategic Games, Strictly competitive Games	Assessment
CO-3	Methods to solve the Strategic Games with Matrix 2-person Games, 3-person Games	Assessment
CO-4	Introduction of Matrix Games & Linear Programming methods to solve complex Games	Assessment
CO-5	Design the games using by analyzing the Mixed Strategy Nash Equilibrium	Assessment
CO-6	Analysis of Game complexity by finite repeated & infinite repeated games	Assessment
CO-7	Design the Games with timeliness and restrict the strategies	Assessment
CO-8	Learn the games complexity by NASH FOLK Theorem	Usage
CO-9	Analyze the Game Design with best response & equality of pay-off	Usage

Course Contents:

Unit	Chapters	Lectures Required
1	**Introduction:** Game Theory, The theory of rational choice, Theory of Competitive Equilibrium, steady State and Deductive Interpretations, Bounded Rationality Terminology and Notation Nash Equilibrium- Strategic Games, Nash Equilibrium Examples Existence of a Nash Equilibrium, Strictly Competitive Games, Bayesian Games: Strategic Games with Imperfect Information	6
2	**Matrix Two-Person Games**(The Basics, The von Neumann Minimax Theorem, Mixed Strategies, Solving 2 × 2 Games Graphically, Graphical Solution of 2 × *m* and *n* × 2 Games, Best Response Strategies	4
3	**Solution Methods for Matrix Games:** Solution of Some Special	5

	Games, Invertible Matrix Games,Symmetric Games, Matrix Games and Linear Programming, Two-Person Nonzero Sum Games(The Basics, 2 × 2 Bimatrix Games, Best Response, Equality of Payoffs,	
4	**Mixed Strategy Nash Equilibrium** Interpretations of Mixed Strategy Nash Equilibrium Correlated Equilibrium Evolutionary Equilibrium Rationalizability and Iterated Elimination of Dominated Actions-Rationalizability Iterated Elimination of Strictly Dominated Actions, Iterated Elimination of Weakly Dominated Actions	**5**
5	**Repeated Games:** The Basic Idea Infinitely Repeated Games vs.\ Finitely Repeated Games Infinitely Repeated Games: Definitions Strategies as Machines Trigger Strategies: Nash Folk Theorems Punishing for a Limited Length of Time	**6**
6	**Game Examples:** 8 Queen Game, Sudoku Puzzle Game, Chess Board Game	**2**
	Total Lecture Hours	**28**

Text Book(s):

- Games Theory An Introduction second edition by E. N Barron Loyola University Chicago Chicago, Illinois

Reference Book(s):

- An Introduction to Game Theory by Martin J. Osborne
- Introduction to Game Theory by StefTijs Tilburg University Tilburg, HindustanBook Agency(India)
- Games of Strategy Theory And Application by Melvin Dresher Prentice – Hall, Inc. Englewood Cliffs, N.J.

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment - 9 Quizzes - 12 Attendance - 4

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	2	3	1	2	3	3	2	1	2	2	2	2.2
CO-2	3	3	3	1	2	3	3	3	2	2	2	2	2.4
CO-3	3	3	3	1	2	3	2	3	2	2	3	3	2.5
CO-4	3	3	3	3	2	3	3	2	2	2	3	3	2.7
CO-5	3	3	3	2	2	3	3	3	2	2	3	3	2.7
CO-6	3	3	3	2	2	2	3	2	2	2	2	2	2.3
CO-7	3	3	3	2	2	2	2	2	2	2	3	2	2.3
CO-8	3	3	3	3	2	3	3	2	2	2	3	3	2.7
CO-9	3	3	3	3	2	3	3	3	2	2	3	2	2.7
Avg	3	2.9	3	2	2	2.8	2.8	2.4	1.9	2	2.7	2.4	2.5

Game Development Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Introduction to Computer Programming C ,C++, Matlab

Course Objectives:

1. To strengthen their problem-solving ability by applying logic & numerical approach.
2. To strengthen the ability to design and represent solutions to problems using Nash Equilibrium and saddle points.
3. To introduce the 2-Person, N-Person Game, Mixed Strategy, Convex Combination

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To explain how the game is implemented through a matrix representation	Familiarity
CO-2	To analyze and decompose the problem into matrix & propose the various solutions using Nash Equilibrium, Mixed Strategy.	Assessment
CO-3	To design the game for 2-person, N-person e.g. Puzzle Game, Chess Board,8 Queen Game	Assessment

List of Experiments

S.No.	Description	Hours
1	There are 100 bankers lined up in each of 100 rows. Pick the richest banker in each row. Javier is the poorest of those. Pick the poorest banker in each column. Raoul is the richest of those. Who is richer: Javier or Raoul	**2**
2	Implement Mixed Strategy Problem & find out the expected payoff	**2**
3	Implement the Mixed strategy Problem and find the saddle point for finite & infinite user	**2**
4	Consider the game with matrix $\begin{bmatrix} 3 & -2 & 4 & 7 \\ -2 & 8 & 4 & 0 \end{bmatrix}$. Solve the game, find the best response for player1 to the strategy$(\frac{1}{4}, \frac{1}{2}, \frac{1}{8}, \frac{1}{8})$. What is 2nd best response to 1st best response?	**2**
5	Consider the game	**2**

– – – –

	$\begin{matrix}1 & -3 & -5 & 1\\ 0 & 4 & 4 & -2\\ 0 & 0 & 8 & 3\\ 0 & 0 & 0 & 50\end{matrix}$ Solve this game by finding v(A) and the optimal strategies.	
6	Consider the matrix for two-player $\begin{matrix}1,0 & 1,3 & 3,0\\ 0,2 & 0,1 & 3,0\\ 0,2 & 2,4 & 5,3\end{matrix}$ Find the Nash Equilibrium	**2**
7	Consider the matrix $\begin{matrix}1,1 & 3,x & 2,0\\ 2x,3 & 2,2 & 3,1\\ 2,1 & 1,x & x^2,4\end{matrix}$ Find x so that the game has exactly two pure Nash equilibrium?	**2**
8	Consider the game in which each player has two strategies Wait and Go. The game matrix is $\begin{bmatrix}1,1 & 1-€,2\\ 2,1-€ & 0,0\end{bmatrix}$ Find the correlated equilibria corresponding to the Nash equilibria 0<€<1	**2**
9	Implement the prisoner's dilemma game with matrix	**2**
10	The third column of the matrix $\begin{matrix}0 & 8 & 5\\ 8 & 4 & 6\\ 12 & -4 & 3\end{matrix}$ is dominated by a convex combination. Reduce the matrix and solve the game.	**2**
11	Use dominance to solve the following game even though it has no inverse $A = \begin{matrix}-4 & 2 & -1\\ -4 & 1 & 4\\ 0 & -1 & 5\end{matrix}$	**2**
12	Design the magic Square game. A Game has a matrix in which each row has a row sum that is the same as each of the column sums. For example $\begin{matrix}11 & 24 & 7 & 20 & 3\\ 4 & 12 & 25 & 8 & 16\end{matrix}$ $A = \begin{matrix}17 & 5 & 13 & 21 & 9\\ 10 & 18 & 1 & 14 & 22\\ 23 & 6 & 19 & 2 & 15\end{matrix}$	**2**
13	Design the 9×9 Sudoku puzzle game	**2**
14	Implement the chessboard for 2 users and find the optimal strategy	**2**
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Books

- An Introduction to Game Theory by Martin J. Osborne
- Introduction to Game Theory by Stef Tijs Tilburg University Tilburg, Hindustan Book Agency(India)
- Games of Strategy Theory and Application by Melvin Dresher Prentice – Hall, Inc. Englewood Cliffs, N.J.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	1.8
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	2.3
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	2.3
Average	3	2.8	2.5	2.8	3	1.8	1	1.8	1.8	1	2	2.8	

Information Auditing and Risk Management

Course Name: Information Auditing and Risk Management
Course Code: XXXXXX **Course Credits: 3-0-0 CORE/ELECTIVE:** ELECTIVE
Prerequisite: NIL

Course Objectives

- Targets project leaders involved in managing risk in capital projects.
- Providing a robust introduction of Enterprise Risk Management (ERM) and the ISO 31000 risk management standard.
- Exploring the practical processes involved in identifying, and evaluating internal and external risks to an organization.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To learn to explain why it is important to design interactive products that are usable, define key terms used in interaction design	Familiarity
CO-2	To learn to explain key theories used in the design of interactive products and to explain the importance of iteration, evaluation, and prototyping in interaction design	Familiarity
CO-3	To gather data in the context of developing a simple interactive product using suitable techniques	Assessment
CO-4	To produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles and to evaluate an interactive product using suitable techniques	Assessment
CO-5	To communicate effectively to peers and specialists about requirements, design, and evaluation activities relating to interactive products	Usage
CO-6	To define a suitable program of user involvement that treats users ethically and fairly.	Usage

Course Contents:

Unit	Topic	Lectures Required
1	Introduction: Overview of course objectives and agenda, Interactive exercise – participants will complete a survey on the level of maturity of project risk management in their organization. Introduction to the Construction Industry Institute's Risk Management best practice area and its role in improving project performance	**4**
2	Risk Management Process: Introduction to risk management Owner and contractor perspectives on risk, The risk management process, Applying	**8**

	risk management throughout the project lifecycle, Roles and responsibilities	
3	Risk Identification: Major sources of risk, Risk identification methods – brainstorming, structured interviews, documentation review and risk checklists	**6**
4	Supporting tools: Risk Register template, Risk Breakdown Structure(RBS), Construction-focused Risk Checklist, Using the Risk Register template to document identified risks	**10**
5	Risk Assessment: The assessment process for identified risks, Selecting an appropriate risk assessment level for each project, Level 1 – Risk Identification, Level 2 – Probability & Impact	**4**
6	Utilizing the **Risk Assessment tables**, Recording assessment results in the Risk Register	**5**
7	Risk Response: Developing risk response plans and actions, Risk response strategies, Examples of "actionable" risk responses, Project contingency	**3**
8	Risk Monitoring: Tracking and reporting risks using the Risk Register, Monitoring existing risks and execution of risk response plans and actions, Integrating risk status into regular project communications and reporting	**2**
	Total Lecture Hours	**42**

Reference Books

- Risk Management, The Blackford Centre.
- Fundamentals of Risk Management: Understanding, Evaluating and Implementing Effective Risk Management
- Operational Risk Management: Best Practices in the Financial Services Industry

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	1	2	3	3	2	1	1	1	3	2.2
CO-2	3	2	1	2	1	1	2	3	2	1	1	3	1.8
CO-3	3	3	3	3	2	1	2	2	2	1	1	2	2.1
CO-4	3	3	2	3	2	1	2	3	2	1	1	2	2.1
CO-5	3	3	3	3	2	1	2	3	2	1	1	3	2.3
CO-6	3	3	3	3	2	1	2	3	2	1	1	3	2.3
Average	3	2.8	2.5	2.5	1.8	1.3	2.2	2.7	1.8	1	1	2.7	2.1

Information Modeling

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Database systems, Data Mining

Course Objectives:

1. Learn to build an information modeling.
2. Learn the Concept of data and process modeling.
3. Learn the Concept of Component modeling.
4. Apply information modeling techniques to solve real-life problems.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the basics of information modeling application and their usages in different areas	Familiarity
CO-2	To be familiar with the basics of various modeling techniques	Familiarity
CO-3	Ability to apply modeling techniques on real-life scenarios to solve them easily	Assessment
CO-4	Ability to apply information modeling with Linked data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Information Model:** Introduction, needs; Components of the information model. **Information Modeling:** Introduction: Why? What? How? Goals; Concepts; Information Modeling Vs Data Modeling.	8
2	**Data Modeling:** Introduction; Workflow of Data Modeling; Data Modeling Notations and Languages; Data Modeling Concepts; Challenges in Data Modeling.	6
3	**Meta Modeling:** Introduction; Concepts; Requirements on Metamodeling Notations; IRDS - Information Resource Dictionary Standard; Repositories; Introduction to Ontology; Analyzing and Comparing Ontologies with Meta-Models.	7
4	**Process Modeling:** Introduction; Workflow Management; Process Modeling; Workflow Management System; Executing Processes; Information Delivery Manuals and Model View Definitions.	6

5	**Data, Ontology, and Component Modelling:** A Taxonomic Class Modelling Methodology for Object-Oriented Analysis; Comprehension of Hierarchical ER Diagrams Compared to Flat ER Diagrams; Constraints on Conceptual Join Paths; A Service-Oriented Component Modelling Approach; Evaluation of Component-Based Development Methods.	**7**
6	**Information Modelling and Linked Data:** Introduction; Concepts of Linked Data and the Semantic Web; Technology: The Semantic Web Stack; Multiple Interlinked Models; Dynamic, Semantic Model Extensions; Querying and Reasoning	**8**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- John Krogstie (SINTEF, Norway), Terry Halpin (Neumont University, USA), and Keng Siau (Missouri University of Science and Technology, USA): Information Modeling Methods and Methodologies: Advanced Topics in Database Research, IGI- Global, August 2004.
- André Borrmann, Markus K¨onig, Christian Koch, Jakob Beetz: Building Information Modeling, Springer,

Suggested Reference Book(s):

- Charrel, Pierre-Jean; Jaakkola, Hannu; Kangassalo, Hannu; Kawaguchi, Eiji: Information Modelling and Knowledge Bases, Frontiers in artificial intelligence and applications,

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	1	1	2	1	1	1	1	1	2	3	1.4
CO-2	3	1	1	2	2	1	1	1	1	1	2	3	1.6
CO-3	2	2	2	3	3	2	1	1	2	1	3	3	2.1
CO-4	3	2	3	3	3	2	1	1	1	1	3	3	2.2
Average	2.5	1.5	1.8	2.3	2.5	1.5	1	1	1.3	1	2.5	3	1.8

Ethics and Information Technology

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: None
Course Objectives:

1. The course will discuss the social impacts of computers in information technology.
2. Students will be given a broad overview of relevant topics to include free speech, privacy, security and the law
3. Understand the importance of ethical issues that emerge from the widespread use of information technology.
4. Professional and ethical responsibilities based on community values and the law will be discussed.
5. This course will focus on the economic, social, cultural, and global impacts of decisions that are made relating to information technology.
6. Understand the ethical issues associated with confidentiality and privacy as they relate to information technology.
7. Students will become familiar with organizations, laws, and regulations related to computer ethics and individual conduct in cyberspace.
8. Students will apply critical thinking skills to evaluate cyber ethics issues.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Demonstrate knowledge of current models of information and computer ethics.	Familiarity
CO-2	Apply ethical theories to interpret personal and group behavior when using a variety of information technology tools.	Assessment
CO-3	Evaluate the nature of ethical choices made by self and others when serving various roles that expose social and multicultural differences.	Assessment
CO-4	Construct written arguments in a variety of formats on the evolving nature of ethical norms relating to new technologies	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Defining key terms: Cyber ethics and Cyber technology, Four Developmental Phases in Cyber technology, Are Cyber ethics Issues Unique Ethical Issues? Digital Piracy, Cyber ethics as a Branch of	5

	Applied Ethics: Three Distinct Perspectives, A Comprehensive Strategy for Approaching Cyber ethics Issues, Ethics, and Morality.	
2	**Ethical Concepts and Critical Thinking:** Discussion of various scenarios: The "Runaway Trolley": A Classic Moral Dilemma, A Controversial Policy in America, A Dilemma Involving Conflicting Duties, Character-Based Ethical Theories, Integrating Aspects of Classical Ethical Theories into a Single Comprehensive Theory, Constructing an Argument: Valid Arguments, Sound Arguments, Invalid Arguments, Inductive Arguments, Fallacious Arguments, A Seven-Step Strategy for Evaluating arguments, Identifying some common fallacies.	**6**
3	**Professional Ethics and Privacy:** Professional Ethics, Safety-Critical Software, Professional Codes of Ethics and Codes of Conduct, Conflicts of Professional Responsibility: Employee Loyalty and Whistle-Blowing, Moral, Responsibility, Legal Liability, and Accountability, Risk Assessment in the Software Development Process, Do Some Computer Corporations Have Special Moral Obligations? **Privacy:** Personal privacy, Importance of Privacy, Gathering Personal Data: Monitoring, Recording, and Tracking Techniques Exchanging Personal Data: Merging and Matching Electronic Records, Mining Personal Data, Protecting Personal Privacy in Public Space, Privacy-Enhancing Technologies, Privacy Legislation, and Industry Self-Regulation.	**6**
4	**Security in Cyberspace:** Security in the context of cyber technology, Three categories of cybersecurity, Hacking, and "The Hacker Ethic, Cyberterrorism, Information Warfare(IW), Cybersecurity and Risk Analysis.	**5**
5	**Cyber Crime:** Cybercrimes and Cybercriminals, Hacking, Cracking, and Counterhacking, Defining Cybercrime, Three Categories of Cybercrime: Piracy, Trespass, and Vandalism in Cyberspace, Cyber-Related Crimes, Technologies and Tools for Combating Cybercrime, National and International Laws to Combat Cybercrime. Various scenarios: Virtual Casino, Prosecuting a Computer Corporation in Multiple Countries, The Pirate Bay Web Site, Are WikiLeaks' Practices Criminal? **Intellectual property:** What is Intellectual Property?Copyright law and Digital Media, Patents, Trademarks, and Trade Secrets, Jurisdictional Issues Involving Intellectual Property Law, Philosophical Foundations for Intellectual Property Rights, The Free Software and the Open Source Movements,	**8**
6	**Regulating Commerce:** Background Issues and Some Preliminary Distinctions, Four Modes of Regulation: The Lessing Model, Digital Rights Management and the Privatization of Information Policy, The Use and Misuse of (HTML) Metatags and Web Hyperlinks, Email-Spam, Free Speech vs. Censorship and Content Control in Cyberspace, "Network Neutrality" and the Future of Internet Regulation. algorithms.	**6**

7	**Community in CyberSpace:** Online Communities and Social Networking Services, Virtual Environments and Virtual Reality, Cyber Identities and Cyber Selves, AI, and its implications.	**4**
8	**Ethical aspects of emerging technologies:** Converging Technologies and Technological Convergence, Bioinformatics and Computational Genomics, Nanotechnology and Nano Computing, Autonomous Machines and Machine Ethics, A "Dynamic" Ethical Framework for Guiding Research in New and Emerging Technologies.	**2**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Tavani, H.T. (2010). Ethics and technology: Controversies, questions, and strategies in ethical computing (3rd ed.) Massachusetts, John Wiley & Sons Inc. [ISBN: 978-0- 470-50950-0].

Suggested Reference Book(s):

- Blackley, J. A., Peltier, J., & Peltier, T. (2003) Information Security Fundamentals, 1st ed. Boca Raton, FL. Auerbach Publications. [ISBN: 0849319579/9780849319570].

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Ethics and Information Technology)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	

Knowledge-Based AI: Cognitive Systems

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Discrete Mathematics, Programming Languages

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of- the-art research literature in knowledge-based artificial intelligence. After successful completion of this course, students will be able to:

1. Understand concepts, methods, and prominent issues in knowledge-based artificial intelligence
2. Learn specific skills and abilities needed to apply those concepts to the design of knowledge-based AI agents
3. Understand the relationship between knowledge-based artificial intelligence and the study of human cognition.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of knowledge-based AI & Cognitive Systems	Familiarity
CO-2	Understanding various fundamental concepts & techniques related to AI as well as cognitive systems.	Familiarity
CO-3	Learning & implementing various reasoning methods such as common sense reasoning, analogical reasoning, etc	Usage
CO-4	Designing & creating as well as metacognition knowledge	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Introduction to KBAI & Cognitive Systems, Where Knowledge-Based AI fits into AI as a whole - Cognitive systems: what are they? - AI and cognition: how are they connected?	5
2	**Fundamentals:** Semantic Networks - Generate & Test - Means-Ends Analysis - Problem Reduction - Production Systems	5
3	**Common Sense Reasoning**: Frames - Understanding - Common Sense Reasoning - Scripts	4
4	**Planning & Learning:** Logic, Planning, Learning by Recording Cases - Incremental Concept Learning - Classification - Version	6

	Spaces & Discrimination Trees	
5	**Analogical Reasoning:** Case-Based Reasoning - Explanation-Based Learning - Analogical Reasoning	**5**
6	**Visuospatial Reasoning:** Constraint Propagation - Visuospatial Reasoning	**5**
7	**Design & Creativity:** Configuration - Diagnosis - Design - Creativity	**6**
8	**Metacognition:** Learning by Correcting Mistakes - Meta-Reasoning - AI Ethics	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- "Artificial Intelligence: A Modern Approach", Stuart Russell and Peter Norvig, 3rd Edition
- "Artificial Cognitive Systems: A Primer", David Vernon, 1st Edition

Suggested Reference Book(s):

- "Artificial Intelligence by Example", Denis Rothman

Other useful resources (s):

1. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/106/105/106105077/
2. Link to topics related to course:
   - https://www.youtube.com/watch?v=0Alhb1HDsNw
   - https://www.youtube.com/watch?v=JMUxmLyrhSk
   - https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Knowledge-Based AI: Cognitive Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	3	3	3	1	1	1	2	2	1	2	1.9
CO-4	2	3	3	3	2	1	1	1	2	3	1	2	2
Average	2	2.5	2.8	2.8	2.5	1	1	1	2	2.3	1.3	2	1.9

Reinforcement Learning

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Probability & Statistics, Machine Learning

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of- the-art research literature in deep reinforcement learning. After successful completion of this course, students will be able to:

1. Structure of a reinforcement learning problem
2. Understand and apply basic RL algorithms for simple sequential decision-making problems in uncertain conditions.
3. Evaluate the performance of the solution
4. Interpret state-of-the-art RL research and communicate their results.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of Reinforcement Learning	Familiarity
CO-2	Understanding Probability Primer Techniques in detail.	Familiarity
CO-3	Learning & implementing various methods & techniques such as TD methods, Monte Carlo, Markov Decision Process, etc.	Usage
CO-4	Learning & understanding policy gradients along with its advantages and disadvantages.	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.	2
2	**Probability Primer:** Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.	4
3	**Markov Decision Process:** Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision	6

	process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.	
4	**Prediction & Control by Dynamic Programming:** Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.	**6**
5	**Monte Carlo methods for Model Free Prediction & Control :** Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.	**6**
6	**TD Methods:** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.	**6**
7	**Function Approximation Methods:** Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, After states, Control with function approximation, Least squares, Experience replay in deep Q-Networks.	**6**
8	**Policy Gradients:** Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition
- "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia

Suggested Reference Book(s):

- "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy

Other useful resources (s):

1. Link to NPTEL course contents:
- https://nptel.ac.in/courses/106/106/106106143/
2. Link to topics related to course:

- https://www.youtube.com/watch?v=JgvyzIkgxF0
- https://www.youtube.com/watch?v=LzaWrmKL1Z4

Evaluation Scheme:

S. No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Reinforcement Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	2	2	2	2	1	2	1.8
CO-2	2	3	3	3	3	1	3	2	2	2	1	2	2.3
CO-3	2	3	3	3	3	2	3	2	2	2	1	2	2.3
CO-4	2	3	3	3	2	1	2	3	2	3	2	2	2.3
Average	2	2.8	2.8	2.8	2.5	1.3	2.5	2.3	2	2.3	1.3	2	2.2

Architecting Distributed Cloud Applications

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0
Pre-requisite: Cloud Computing, Distributed applications, Basic networking concepts.
Course Objectives:

1. To understand cloud distributed applications.
2. To know the benefits and challenges of microservices architecture.
3. To learn the fundamentals of service endpoints, scalability, and availability.
4. To know the fundamentals of messaging with queues.
5. To understand best practices for managing service configuration.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to cloud computing and distributed cloud applications	Familiarity
CO-2	Network Communication in distributed cloud applications	Assessment
CO-3	Message Communication in distributed cloud applications	Assessment
CO-4	Versioning, upgrading, and configuration of distributed cloud applications	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Module 1:** **Cloud Computing Introduction:** Cloud computing definition, benefits of cloud computing. What are cloud applications, why develop cloud applications, what are orchestrators and containers in the cloud, the difference between orchestrators and containers? What are micro-services, why convert monolith applications to micro-services, micro-service architectural myths, auto-scaling of cloud microservices?	5
2	**Module 2: Network Communication** Network issues for distributed cloud applications, service endpoint scalability, and availability, forward and reverse proxies, cluster DNS, reverse proxy load balancers. What are service APIs for distributed cloud applications? Fault-tolerant network communication, circuit breaking.	4
3	**Module 3:Messiging Communication** What is message communication, benefits of message communication,	4

	messing with queues, fault-tolerant messaging process, some queue features?	
4	**Module 4: Versioning, upgrading, and configuration** Service update options, rolling updates feature, shutting down a service, gracefully shutting down a service, service configuration, and reconfiguration.	**4**
5	**Module 5: Leader Election** What is leader election, why we need leader, main roles, and responsibilities of a leader, leader election via lease, leader election via queue messages?	**5**
6	**Module 6: Storage Services** Introduction to data storage services, data temperature, object storage services, database storage services, backup restore, and disaster recovery.	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568
- Wilder, B. (2012). Cloud architecture patterns: using Microsoft azure. " O'Reilly Media, Inc.".

Suggested Reference Book(s):

- Srinivasan, V., Ravi, J., & Raj, J. (2018). Google Cloud Platform for Architects: Design and manage powerful cloud solutions. Packt Publishing Ltd.

Other useful resources (s):

This course is designed based on a famous course provided by Microsoft. Links to courses and content are as follows:

- https://courses.edx.org/courses/course- v1:Microsoft+DEVOPS200.9x+3T2019/course/
- https://azure.microsoft.com/en-in/blog/architecting-distributed-cloud-applications- free-video-course/
- https://www.youtube.com/watch?v=xJMbkZvuVO0&list=PL9XzOCngAkqs0Q8Z RdafnSYExKQurZrBY

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Architecting Distributed Cloud Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	1	1	1	1	1	1	1	1	1.4
CO-2	3	3	3	2	2	1	1	1	1	1	3	1	1.8
CO-3	3	3	3	2	2	2	1	1	1	1	3	1	1.9
CO-4	3	3	3	2	2	1	1	1	1	1	3	1	1.8
Average	3	3	2.8	1.8	1.8	1.3	1	1	1	1	2.5	1	1.8

Architecting Distributed Cloud Application Lab

COURSE CODE: XXXXX COURSE CREDITS: 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Cloud Computing, Basic Networking

Course Objectives:

1. Learn to create a VM on the Microsoft Azure cloud.
2. Create Docker and install container on the docker.
3. Learn to run a network, communication, and storage services for cloud applications on containers.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Install Docker and container. Deploy virtual machine on Microsoft Azure.	Familiarity
CO2	Create sample microservice on cloud container	Usage
CO3	Perform messaging service on cloud containers	Usage
CO4	Learn about storage service on cloud containers	Usage

List of Experiments

S No	Description	Hours
1	Deploy a Microsoft Azure Virtual Machine using free account. Create an account on Visual Studio Team Services (VSTS).	4
2	Install Docker on Ubuntu Machine.	4
3	Create a container image and run the container	4
4	Build a Sample Application with Microservices	4
5	Message Communication of Distributed Cloud Applications	4
6	Storage Services for Distributed Cloud Applications	4
7	Small Project using cloud application services	4
	Total Lab hours	**28**

Suggested/Resources:
This course is designed based on famous course provided by Microsoft. Links to courses and content are as follows:

- https://courses.edx.org/courses/course-v1:Microsoft+DEVOPS200.9x+3T2019/course/
- https://azure.microsoft.com/en-in/blog/architecting-distributed-cloud-applications-free- video-course/

- https://www.youtube.com/watch?v=xJMbkZvuVO0&list=PL9XzOCngAkqs0Q8ZRdaf nSYExKQurZrBY

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	1	1	1	1	1	1	1	1	1	1.4
CO2	3	3	3	2	2	1	1	1	1	1	3	1	1.8
CO3	3	3	3	2	2	2	1	1	1	1	3	1	1.9
CO4	3	3	3	2	2	1	1	1	1	1	3	1	1.8
Average	3	3	2.8	1.8	1.8	1.3	1	1	1	1	2.5	1	1.8

Optimization Methods in Business Analytics

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0

Pre-requisite: Algorithm design

Course Objectives:

1. Learn the analytics of optimizing algorithms.
2. Learn various computing algorithms in solving complex problems.
3. Apply important algorithmic design paradigms and methods of analysis.
4. Synthesize efficient algorithm design in common engineering design situations.
5. Learn to analyze the specifications and sensitivity of the algorithms.
6. Learn the improvisations of algorithms.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Comprehension of the design of the optimized algorithm.	Familiarity
CO-2	Demonstrate familiarity with major algorithms.	Assessment
CO-3	Analyze the different types of algorithms.	Assessment
CO-4	Apply algorithms for simulating the decision.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to optimization technique:** Examples of optimization problems: Shortest path problem, integer knapsack; Unconstrained optimization; Unconstrained optimization; Convex set and Convex function; Duality: Geometric interpretation, Lagrangian Saddle point, Weak and strong duality.	8
2	**Linear programming:** Linear programming problem; Basic feasible solution; Geometric solution; Optimality condition and simplex method; Two-phase simplex method; Interior point method, Duality in linear programming, Karmarkars method.	8
3	**Transportation problem:** Characteristics of transportation problem; Northwest Corner Method; Least Cost Method; Vogel's Approximation Method **Assignment problem:** Characteristics of assignment problem, Hungarian methods, Dual of assignment problem, optimality of Hungarian methods.	6

4	**Integer programming:** Complexity of simplex methods**;** Elementary notions; Formulation; Solving 0-1 problem; Branch-Bound for integer programming; Cutting plane problem; All integer primal and Dual algorithm;	**8**
5	**Network models:** Characteristics of network models; Shortest path problem; Successive shortest path problem; Maximum flow problem; Minimum cost flow problem.	**6**
6	**Nonlinear programming:** Quadratic programming: Lagrange multiplier and KKT, Steepest descent method. **Sensitivity analysis:** dummy variable, linear programming, integer linear programming, nonlinear models and statistical test: t-test, chi- square test, Wilcoxon signed-rank	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons, 4th edition, 2009.
- H. S. Kasane & K. D. Kumar, Introductory Operations Research, Springer (India), Pvt. Ltd., 2004
- Optimization for Engineering Design. K Deb.

Suggested Reference Book(s):

- Sheskin, David J. (2003) Handbook of Parametric and Nonparametric Statistical Procedures. CRC Press.
- Optimization concepts and applications in engineering, A. D. Belegundu and T. R. Chandrupatla.
- Linear and Nonlinear programming. Stephen G. Nash and A. sofer

Other useful resources (s):

- Link to NPTEL course contents: https://nptel.ac.in/courses/111/105/111105039/
- Link to NPTEL course contents: https://nptel.ac.in/courses/111/104/111104068/
- Link to NPTEL course contents: https://nptel.ac.in/courses/112/106/112106131/

Link to topics related to course:

- https://nptel.ac.in/courses/112/106/112106134/
- https://nptel.ac.in/courses/112/106/112106131/
- https://nptel.ac.in/courses/106104019/26
- https://nptel.ac.in/courses/111/105/111105039/

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optimization Methods in Business Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

From Graph to Knowledge Graph

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0
Pre-requisite: Basic programming skills

Course Objectives:

1. You will learn graph representations.
2. Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.
3. Understand how to apply the tools and infrastructure to build and query knowledge graphs.
4. Use knowledge graphs in modern search applications.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn graph representations	Familiarity
CO-2	Utilize fundamentals to build knowledge graphs	Assessment
CO-3	Understand the algorithms and techniques for crawling web sites, structured data extraction, and information extraction from unstructured text.	Assessment
CO-4	Understand how to apply the tools and infrastructure to build and query knowledge graphs.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Introduction and Overview Introduction to Graphs, Introduction to Knowledge graphs	**4**
2	Graph Properties and Applications: Graph basics, Graph Applications	**4**
3	Graph Representation Learning Embeddings and Graph Embeddings	**4**
4	Knowledge Graph (KG) - Fundamentals and Construction. KG Fundamentals How to Build a Knowledge Graph	**5**
5	Knowledge Graph (KG) - Inference and Applications KG Inference. How to Use a Knowledge Graph Why We Need Knowledge Graphs: Applications KG Applications	**6**
6	Knowledge graph analytics	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Fensel, Dieter (et al.), "Knowledge Graphs Methodology, Tools and Selected Use Cases", Springer, 2020.
- Qi, G. et. al, "Knowledge Graph", Springer, 2020, ISBN 978-981-10-8177-4

Suggested Reference Book(s):

- Jeff Z. Pan, Guido Vetere, Jose Manuel Gomez-Perez, Honghan Wu, " Exploiting Linked Data and Knowledge Graphs in Large Organisations", Springer International Publishing, Print ISBN 978-3-319-45652-2, DOI https://doi.org/10.1007/978-3-319- 45654-6

- Mayank Kejriwal, "Domain-Specific Knowledge Graph Construction", Springer, DOI: 10.1007/978-3-030-12375-8

Other useful resources (s):

- Journal, "Knowledge-Based Systems", Springer

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (From Graph to Knowledge Graph)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

From Graph to Knowledge Graph Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Basic programming skills

Course Objectives:

1. The lab is designed to provide a versatile means to perform learning tasks over a knowledge graph.
2. Use Machine Learning over a Knowledge Graph

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Build a knowledge graph from documents	Usage
CO2	Building a knowledge graph from a text	Usage
CO3	Build a Small Knowledge Graph	Usage
CO4	Understand the Graph Databases	Assessment
CO5	Familiarity with graph computing Frameworks	Familiarity
CO6	Able to Visualization of graphs	Assessment

List of Experiments

S No	Description	Hours
1	Introduction to Linked Data. Loan Prediction Practice Problem (Using Python) Build a knowledge graph from documents	4
2	Build a Small Knowledge Graph Creating and Processing Linked Data Building a knowledge graph from text A Knowledge Graph understanding and implementation	4
3	Build a Small Knowledge Graph Building a knowledge graph in python from scratch	4
4	Introduction to Graph Databases A Python Library for Knowledge Graph Embedding	6
5	Introduction to graph computing Frameworks	4
6	Introduction to Graph Visualization	6
	Total Lab hours	**28**

Suggested/Resources:

- Grakn KGLIB (Knowledge Graph Library) https://github.com/.
- Online resources.

- Fensel, Dieter (et al.), “Knowledge Graphs Methodology, Tools and Selected Use Cases”, Springer, 2020.

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Avg	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Probabilistic Graphical Models

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Machine learning and Probability

Course Objectives:

1. Learn introductory concepts in probabilistic graphical models.
2. Able to model problems using graphical models.
3. Able to model problems using design inference algorithms.
4. Learn the structure of the graphical model from data

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn introductory concepts in probabilistic graphical models	Familiarity
CO-2	Able to model problems using graphical models.	Assessment
CO-3	Able to model problems using design inference algorithms.	Assessment
CO-4	Analyze the structure of the graphical model from data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Fundamentals I**: Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family;	3
2	**Fundamentals I**I: Fundamentals of Graph Theory – Nodes and Edges, Paths and Trails, Cliques, Subgraphs, Cycles, and Loops.	3
3	**Graphical Models** I: Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields), Dynamic Models (Hidden Markov Model & Kalman Filters) and Factor Graph;	6
4	**Graphical Models II**: Conditional Independence (Bayes Ball Theorem and D-separation), Markov Blanket, Factorization (Hammersley-Clifford Theorem), Equivalence (I-Maps & Perfect Maps); Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.	6
5	**Inference in graphical models I**: Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Junction Tree Algorithm; Belief Propagation (Sum-Product);	6

6	**Inference in graphical models I** I: Approximate Inference - Variational Methods (Mean Field, Kikuchi & Bethe Approximation), Expectation Propagation, Gaussian Belief Propagation; MAP Inference - Max-Product, Graph Cuts, Linear Programming Relaxations to MAP (Tree-Reweighted Belief Propagation, MPLP); Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs (Collapsing & Blocking), Particle filtering	**6**
7	**Learning in Graphical Models I:** Overview, Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudolikelihood, Bayesian Estimation, Conditional Likelihood,	**6**
8	**Learning in Graphical Models II:** Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Structure Search, L1 priors.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Koller, D. and Friedman, N. (2009). Probabilistic Graphical Models: Principles and Techniques. MIT Press.

Suggested Reference Book(s):

- Jensen, F. V. and Nielsen, T. D. (2002). Bayesian Networks and Decision Graphs. Information Science and Statistics. Springer, 2nd edition.
- Kevin P. Murphy (2013) Machine Learning: A Probabilistic Perspective. 4th Printing. MIT Press.
- Barber, D. (2011). Bayesian Reasoning and Machine Learning. Cambridge University Press, 1st edition.
- Bishop, C. M. (2011). Pattern Recognition and Machine Learning(Information Science and Statistics). Springer, 2nd printing.
- Wainwright, M. and Jordan, M. (2008). Graphical Models, Exponential Families, and Variational Inference. Foundations and Trends in Machine Learning, 1:1–305.

Other useful resource(s):

- Conference papers and journal articles

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Probabilistic Graphical Models)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.75**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.75**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.08**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.25**	**1.5**	**2**	1.89

Image Analysis and Pattern Recognition

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0

Pre-requisites: Linear algebra, Matrices, Matrix Operations, Determinants, Systems of Linear Equations, Eigenvalues, Eigenvectors, Statistics and probability, Programming experience, preferably in MATLAB, and/or C/C++/C#/Python/Java

Course Objective:
The course aims to introduce the student to various image processing techniques. The student learns about image fundamentals, describes the main characteristics of digital images, how they are represented, mathematical transforms such as Fourier, Cosine transforms, Singular value decomposition, 2D Wavelet transform, image enhancement techniques, Image restoration and denoising, segmentation, lossy and lossless data compression algorithms, binary and color image processing. The student will be exposed to dealing with image data through programming assignments using MatLab, and/or C/C++/C#/Python/Java.

Course Outcome:
Upon completion of this course, a successful student should be able to design and implement programs that deal with image data.

- To understand how digital images are represented, manipulated, encoded, and processed, with emphasis on algorithm design, implementation, and performance evaluation.
- Emphasis will be to develop engineering skills and intuitive understanding of the tools used in Image Processing.
- The students would be encouraged to design and develop the image processing algorithms/tools for real-life problems.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To understand the different images and their processing	Familiarity
CO-2	To understand the concept of Image transformation Algorithms/techniques	Assessment
CO-3	To understand the concepts of lossy and Lossless compression Algorithms/techniques	Assessment
CO-4	To understand the concepts of Image enhancement and Segmentation Algorithms/techniques	Assessment
CO-5	To understand the concepts of Image Restoration and Denoising Algorithms/techniques	echnical skills
CO-6	To understand the concepts of Binary and Color image processing	Assessment

CO-7	To understand the concepts of Object recognition decision-theoretic methods and structural methods	chnical skills

Course contents:

Unit	Topic	Lectures required
1	**Introduction to Digital Image Processing** Introduction to images and its processing, Components of image processing systems, image representations, Image file formats, Applications of digital image processing, image sampling, and quantization, Image Analysis, Intensity transformations, contrast stretching, Correlation, and convolution, Smoothing filters, sharpening filters, gradient, and Laplacian.	3
2	**Image Transformation Techniques** Need for transform, Fourier, Cosine transforms, Haar, KL Transform, Singular value decomposition, 2D Wavelet transform, Different properties of image transform techniques.	4
3	**Image Compression Basics** Concept of image compression, lossless techniques (Huffman Coding, Arithmetic, and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Multi-Resolution Analysis, and Still Image Compression Standards (JBIG and JPEG),	4
4	**Image Enhancement** **Enhancement in spatial and transform domain,** histogram equalization DirectionalSmoothing, Median, Geometric mean, Harmonic mean, Contrahar monic mean filters, Homomorphic filtering, Color image enhancement.	3
5	**Image Restoration and Denoising** Image degradation, Type of image blur, Classification of image restoration techniques, image restoration model, Linear, and non-linear restoration techniques, Image denoising, Median filtering	3
6	**Image Segmentation** **Classification of image segmentation techniques,** Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation	4
7	**Binary and Color image processing** Binarization, Basic Set theory, Binary morphological operations, and its properties, Color Image Representation in MATLAB, Converting Between Color Spaces, The Basics of Color Image Processing, Color Transformations, Spatial Filtering of Color Images, Working Directly in RGB Vector Space	3
8	**Object Recognition** **Decision theoretic methods:** Matching, Optimal statistical Classifier, Neural network.	4

	Structural methods: Matching shape numbers, String matching, Syntactic recognition of string, Syntactic recognition of tree.	
	Total Lecture Hours	**28**

Recommended Books

- Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008
- Anil K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989.
- Digital Image processing, S Jayaraman, TMH, 2012
- William K. Pratt, *Digital Image Processing*, 3rd Edition, John Wiley, 2001.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	2	3	3	2	2	2	2	2	3	2.5
CO2	3	3	3	2	2	2	2	2	2	2	2	3	2.3
CO3	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO4	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO5	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO6	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO7	3	3	3	3	3	3	2	2	3	2	3	3	2.8
Avg	3	3	3	2.1	2.9	2.3	2	2	2.1	2	2.1	3	2.5

Image Analysis and Pattern Recognition Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE L-T-P: 0-0-2

Pre-requisite: programming, algorithm, matrix operations

Course Objectives: In this lab, you will implement image processing techniques that you will learn during the frontal course. Work in the lab will be carried out in Matlab and OpenCV

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Introduction to basic image processing operations and histogram algorithms	Familiarity
CO2	Introduction to image filtering in spatial and in frequency domains.	Assessment
CO3	Introduction to image restoration.	Assessment
CO4	Introduction of principles of the JPEG baseline coding system.	Assessment
CO5	Getting familiar with the OpenCV library. Basic processing of color images and introduction to video tracking using the Camshaft algorithm.	chnical skills
CO6	Analyze the systems using Laplace transform and Z-transform.	Assessment

List of Experiments

S No	Description	Hours
1	Introduction to MATLAB. In this lab, we will study basic image-processing operations: image resizing and rotation, quantization, and histogram algorithms. We will analyze the effects of resizing and quantization on image quality and the methods to improve the quality and avoid artifacts. Histogram techniques allow us to analyze the distribution of gray levels in an image. In this lab, we will study histogram, histogram normalization, and histogram equalization. Understand the basics of MATLAB syntax, functions, and programming.	4
2	In this lab, we'll study the properties of DFT and two practical applications: 1. Computation of convolution by two methods – direct method (in the spatial domain) and indirect method (in the frequency domain). 2.Computation of edge enhancement by unsharp masking.	4
3	In practical imaging systems, the acquired image often suffers from the effects of blurring and noise. Image restoration algorithms are aimed to restore the original undistorted image from its blurry and noisy version. The lab experiment demonstrates the evolution of restoration algorithms from the simple Inverse Filter, Pseudo Inverse Filter, and Wiener Filter	4
	Mid sem exam	2

4	In this lab, we will present the basic concepts used for JPEG coding and experiment with different coding parameters. The JPEG standard provides a powerful compression tool used worldwide for different applications. This standard has been adopted as the leading lossy compression standard for natural images due to its excellent compression capabilities and its configurability.	**4**
5	OpenCV is an open-source computer vision library, written in C and C++. One of the main goals of OpenCV is to provide a simple-to-use computer vision infrastructure that helps people to build sophisticated vision applications quickly. Among the tools provided by OpenCV are image transformations, histograms, video tracking, 3D vision algorithms, and machine learning.	**4**
6	Implementation of Camshaft algorithm, Mean-shift algorithm and Adaptive adjustment	**4**
	End-semester Exam	**2**
	Total Lab hours	**28**

Suggested/Resources:

- R. C. Gonzalez, R. E. Woods and S. L. Eddins, *Digital Image Processing using MATLAB*. Pearson Education, Inc., 2004 (Library Dewey number 621.368 GON).
- OpenCV library: http://SourceForge.net/projects/opencvlibrary

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Statistics and Exploratory Data Analytics

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0
Pre-requisite: None

Course Objectives:

1. Learn the basic concept of statistics and exploratory data analysis.
2. Learn graphical and modeling techniques for exploring data.
3. Learn Data Transformation and dimensionality reduction of data.
4. Learn data clustering and scatter plots.
5. Apply exploratory data analysis techniques to visualized data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Analyze the concept of statistics and exploratory data analysis.	Familiarity
CO-2	Graphical and modeling techniques for exploring data.	Assessment
CO-3	Implement data transformation, dimensionality reduction	Assessment
CO-4	Apply data clustering and visualized exploratory data through various plots and graphs.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Concept of statistics and exploratory data analysis:** Introduction of data and its types (categorical and quantitative), Central Tendency: mean, median, mode, variance, standard deviation, skewness, kurtosis, exploratory data analysis, and its types, data dimensionality.	5
2	**Graphical and modeling techniques for exploratory data:** Box Plot, Histogram, Multi-Vari Chart, Run Chart, Pareto Chart, Scatter Plot, Stem-and-leaf plot.	5
3	**Data transformation, dimensionality reduction**: Power transformation, standardization, multidimensional scaling, principal component analysis, linear or non-linear dimensionality reduction.	7
4	**Data Clustering Techniques:** Data clustering, Hierarchal methods, optimization method, k-means, and model-based clustering.	5
5	**Smoothing scatter plots and graphical methods for EDA:** Bivariate distribution smooths, curve fitting toolbox, Dendrogram, treemaps, rectangle plots.	6
	Total Lecture Hours	28

Suggested Text Book(s):

- Martinez, W. L.; Martinez, A. R. & Solka, J. (2010). *Exploratory Data Analysis with MATLAB, second edition*. Chapman & Hall/CRC.
- Hoaglin, D C; Mosteller, F & Tukey, John Wilder (Eds) (1983). *Understanding Robust and Exploratory Data Analysis.*
- Andrienko, N & Andrienko, G (2005) *Exploratory Analysis of Spatial and Temporal Data. A Systematic Approach*

Suggested Reference Book(s):

- Tukey, John Wilder (1977). *Exploratory Data Analysis*. Addison-Wesley

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Statistics and Exploratory Data Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Statistics and Exploratory data analytics Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Basic knowledge of python programming and Matlab.

Course Objectives:

1. Learn to explore a dataset
2. Visualization of data
3. Dimensionality reduction of data
4. Cluster findings in a dataset
5. Usage of curve fitting tools

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the basics of MATLAB syntax/python libraries	Familiarity
CO2	Exploring dataset and visualizing data on different charts.	Assessment
CO3	Perform the basic operations of data pre-processing and dimensionality reduction.	Assessment
CO4	Design and analyze clustering techniques.	Usage
CO5	Understanding of curve fitting toolbox.	Usage
CO6	Implementation of dendrogram and treemaps.	Usage

List of Experiments

S No	Description	Hours
1	Introduction to MATLAB/Python Libraries	**2**
2	Exploring dataset and data preprocessing	**2**
3	Importing dataset in python	**2**
4	Implementation of standard deviation and skewness of data	**2**
5	Visualizing data on a histogram	**2**
6	Implementations of the box plot chart	**2**
7	Implementation of data representation in the pie chart	**2**
8	Implementation of data representation in scatter plot	**2**
9	Implementation of a column chart	**2**
10	Implementation of principal component analysis techniques	**2**
11	Implementation of nonlinear dimensionality reduction	**2**
12	Finding cluster in a dataset	**2**
13	Implementation of hierarchal clustering techniques	**2**
14	Implementation of curve fitting toolbox	**2**
	Total Lab hours	**28**

Suggested/Resources:

- Martinez, W. L.; Martinez, A. R. & Solka, J. (2010). *Exploratory Data Analysis with MATLAB, second edition*. Chapman & Hall/CRC.
- Hoaglin, D C; Mosteller, F & Tukey, John Wilder (Eds) (1983). *Understanding Robust and Exploratory Data Analysis.*

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Avg	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Information Visualization

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Basic mathematics courses

Course Objectives:

1. Information visualization offers instruments for reasoning about quantitative information, analyzing, and communicating statistical information.
2. The course overviews the main typologies of data graphics (data-maps, time-series, space-time narrative, relational diagrams, graphs and methods for dimensionality reduction)
3. The course provides a language for discussing data visualizations combined with knowledge of the human perception of visual objects.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Big Data and Large-Scale Computation, Web Technologies	Familiarity
CO-2	Applications and Science, Signal Processing and Data Science tracks	Assessment
CO-3	Game Design and Production and Machine Learning, Data Science and Artificial Intelligence majors	Assessment
CO-4	Machine Learning, Data Science and Artificial Intelligence, Analytics and Data Science minor.	Usage
CO-5	ICT Innovation program's Data Science, Digital Media Technology, Human-Computer Interaction minor, and Life Science Technologies Complex Systems major and minor and Bioinformatics and Digital Health minor.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Foundations for an Applied Science of Data Visualization:** Visualization Stages, Experimental Semiotics Based on Perception, Semiotics of Graphics, Sensory versus Arbitrary Symbols, Gibson's Affordance Theory, A Model of Perceptual Processing, Costs and Benefits of Visualization, Types of Data, Metadata	6
2	**The Environment, Optics, Resolution, and the Display:** The Environment, The Eye, The Optimal Display	4
3	**Lightness, Brightness, Contrast, and Constancy:** Neurons, Receptive Fields, and Brightness Illusions, Luminance, Brightness, Lightness, and	4

	Gamma, Perception of Surface Lightness, Monitor Illumination and Monitor Surrounds	
4	**Color:** Trichromacy Theory, Color Measurement, Opponent Process Theory, Properties of Color Channels, Color Appearance, Applications of Color in Visualization	**4**
5	**Visual Salience and Finding Information:** Eye Movements, V1, Channels, and Tuned Receptors, Preattentive Processing and Ease of Search, Integral and Separable Dimensions: Glyph Design, Representing Quantity, The Searchlight Metaphor and Cortical Magnification	**6**
6	**Static and Moving Patterns:** Gestalt Laws, Texture: Theory and Data Mapping, Perception of Transparency: Overlapping Data, Perceiving Patterns in Multidimensional Discrete Data, Pattern Learning, The Visual Grammar of Node–Link Diagrams, The Visual Grammar of Maps, Patterns in Motion, Perception of Animated Motion, The Processes of Pattern Finding	**6**
7	**Space Perception:** Depth Cue Theory, Depth Cues in Combination, Task-Based Space Perception, Tracing Data Paths in 3D Graphs, Judging the Morphology of Surfaces, Patterns of Points in 3D Space, Perceiving Patterns in 3D Trajectories, Judging Relative Positions of Objects in Space, Judging the Relative Movements of Self within the Environment, Selecting and Positioning Objects in 3D, Judging the "Up" Direction, The Aesthetic Impression of 3D Space (Presence)	**6**
8	**Visual Objects and Data Objects:** Image-Based Object Recognition, Structure-Based Object Recognition, The Object Display, and Object-Based Diagrams, Faces, Coding Words and Images, Labels and Concepts, Concept Mapping, Iconic Images versus Words versus Abstract Symbols, Scenes and Scene Gist	**6**
Total lectures		**42**

Suggested Text Book(s):

- Ware, C., 2020. Information visualization: perception for design. Morgan Kaufmann.

Suggested Reference Book(s):

- Bederson, B.B., Bederson, B.B., and Shneiderman, B. eds., 2003. The craft of information visualization: readings and reflections. Morgan Kaufmann.
- Bergman, E. ed., 2000. Information appliances and beyond: interaction design for consumer products. Morgan Kaufmann.

Other useful resources (s):

- https://www.youtube.com/watch?v=t0B2sxIumh0&list=PLk_jmmkw5S2C1A_ZD3mp Bb3Og_Y1QZ83Z
- https://www.youtube.com/watch?v=IKSRwGZe8Oc

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Introduction to Deep Learning

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0

Pre-requisite:

1) Basic knowledge of Python.
2) Basic linear algebra and probability.

Course Objectives:

1. The goal of this course is to give learners a basic understanding of modern neural networks and their applications in computer vision and natural language understanding.
2. The course starts with a recap of linear models and discussion of stochastic optimization methods that are crucial for training deep neural networks.
3. Learners will study all popular building blocks of neural networks including fully connected layers, convolutional and recurrent layers.
4. Learners will use these building blocks to define complex modern architectures in TensorFlow and Keras frameworks.
5. In the course, project learner will implement a deep neural network for the task of image captioning which solves the problem of giving a text description for an input image.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Linear regression: mean squared error, analytical solution.	Familiarity
CO-2	Logistic regression: model, cross-entropy loss, class probability estimation	Assessment
CO-3	Gradient descent for linear models. Derivatives of MSE and cross-entropy loss functions.	Assessment
CO-4	The problem of overfitting.	Usage
CO-5	Regularization for linear models.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to optimization:** Linear regression, Linear classification Gradient descent, Overfitting problem and model validation, Model regularization, Stochastic gradient descent, Gradient descent extensions9m	**8**

2	**Introduction to neural networks:** Multilayer perceptron (MLP), Chain rule, Backpropagation, Efficient MLP implementation, Other matrix derivatives, what is TensorFlow, our first model in TensorFlow, What Deep Learning is and is not, Deep learning as a language	**8**
3	**Deep Learning for images:** Motivation for convolutional layers11m Our first CNN architecture, Training tips and tricks for deep CNNs, Overview of modern CNN architectures, Learning new tasks with pre-trained CNNs, A glimpse of other Computer Vision tasks8m	**6**
4	**Unsupervised representation learning:** Unsupervised learning: what it is and why bother, Autoencoders 10, Autoencoder applications, Autoencoder applications: image generation, data visualization & more, Natural language processing primer, Word embeddings, Generative models 10, Generative Adversarial Networks, Applications of adversarial approach	**6**
5	**Deep learning for sequences:** Motivation for recurrent layers, Simple RNN and Backpropagation, The training of RNNs is not that easy, Dealing with vanishing and exploding gradients, Modern RNNs: LSTM and GRU, Practical use cases for RNNs	**8**
6	**Final Project:** This week you will apply all your knowledge about neural networks for images and texts for the final project. You will solve the task of generating descriptions for real-world images!	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

Ian Goodfellow, YoshuaBengio, and Aaron Courville, "Deep Learning", The MIT Press, Cambridge, 2016.

- Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer, 2018.

Suggested Reference Book(s):

- Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", 2nd Edition, OReilly Media
- Andrew Ng, "Machine Learning Yearning", available online published by deeplearning.ai

Other useful resources (s):

- http://www.charuaggarwal.net/neural.htm
- https://www.coursera.org/specializations/deep-learning

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Introduction to Deep Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Social Media

COURSE CODE: XXX **COURSE CREDIT:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0
Pre-requisites: Graph Theory, Probability

Course Objectives:

1. Understanding the social media structure.
2. Understanding graph theory, particularly the algebraic description and analysis of graphs and their use in social media studies.
3. Helping scientists, artists, and sociologists understand complex social media phenomena like information diffusion, marketing, and recommendation systems in social media and evolving systems.
4. Acquiring expertise to analyze the social and digital media markets.
5. Providing insight into processing, storing, and visualizing big social media data and social graphs.

Course outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand what constitutes Social and Digital Media	Familiarity
CO-2	Algebraic Graph Analysis	Assessment
CO-3	Design effective and reliable network research projects	Assessment
CO-4	Matrix and Tensor Factorization with Recommender System Applications	Assessment
CO-5	Graph Signal Processing in Social Media	Assessment
CO-6	Big Data Analytics for Social Networks	Assessment

Course Contents:

Unit	Topics	Lectures Required
1	**Graphs in Social and Digital Media** - Dominant social networking/media platforms, Collecting data from social media sites, Social media graphs, Big data issues in social and digital media	3
2	**Mathematical Preliminaries:** Graphs and Matrices & Algebraic Graph Analysis, Matrix decompositions, Applications of graph analysis, Graph clustering, Graph anomaly detection	3
3	**Web Search Based on Ranking** - Information Retrieval, Background, Relevance Beyond the Web Page, Ranking in Heterogeneous Networks	3
4	**Label Propagation and Information Diffusion in Graphs** - Graph construction approaches, Label inference methods,	3

	Diffusion processes, Social network diffusion models	
5	**Graph-Based Pattern Classification and Dimensionality Reduction** - Unsupervised Methods, Supervised Methods, Semi-Supervised Methods	3
6	**Matrix and Tensor Factorization with Recommender System Applications** - Singular Value Decomposition on Matrices for Recommender Systems, Higher Order Singular Value Decomposition (HOSVD) on Tensors A Real Geo-Social System-Based on HOSVD	3
7	**Multimedia Social Search Based on Hypergraph Learning** – Hypergraphs, Game-Theoretic approaches to uniform hypergraph clustering, Spectral clustering for arbitrary hypergraphs	3
8	**Semantic Model Adaptation for Evolving Big Social Data** - Latent Model Adaptation, Parallel and Distributed Approaches for Big Data Analysis, Applications to Evolving Social Data Analysis	3
		28

Suggested Text Book(s):

- Pitas, Ioannis, ed. Graph-based social media analysis. Vol. 39. CRC Press, 2016.

Suggested Reference Book(s):

- Analyzing Social Networks 1st Edition by Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications Ltd; 1 edition
- Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing
- Emerging Research Challenges and Opportunities in Computational SocialNetwork Analysis and Mining by Nitin Agarwal, NimaDokoohaki, Serpil Tokdemir, Lecture Notes in Social Networks, Springer International Publishing

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO- 11	PO- 12	Avg
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

Social Media Lab

COURSE CODE: XXX **COURSE CREDIT:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisites: Graph Theory, Probability, Statistics

Course Objectives:

1. To create a sustainable software and technical ecosystem driven by a large international open-source community
2. To shares common interests in networks and complex systems
3. To focus on visualization and manipulation, simplicity, and extensibility.
4. To complement the statistical analysis to discover, extract, and classify new patterns in network structure and data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn about interactive network exploration and visualization accompanied by the graph theory concepts that drive them	Familiarity
CO-2	To understand the nuances of network visualization	Assessment
CO-3	To understand a conceptual, and also an implementation perspective	Assessment
CO-4	Getting Real-world Graph Datasets explores various networks in Gephi	Assessment
CO-5	Exploring Dynamic and Multilevel Graphs focuses on two special kinds of graphs, dynamic graphs, and multilevel graphs	Assessment
CO-6	Exploring Some Useful Gephi Plugins describes several plugins that are extensively used by researchers and developers while working with Gephi	Assessment

List of Experiments:

S No	Topics	Hours
1	**Social Network Analysis Measuring, Mapping, and Modeling Collections of Connections -** The Network Perspective, The Network Analysis Research andPractitioner Landscape, Social Networks in the Era of Abundant Computation, Node-Link Diagrams: Visually MappingSocial Networks	**4**
2	**Getting Started with NodeXL, Layout, Visual Design, and Labeling -** Downloading and Installing NodeXL, Getting Started with NodeXL, Layout: Arranging Vertices in the Graph Pane, Visual Design: Making Network Displays Meaningful	**4**
3	**Calculating and Visualizing Network Metrics -** Kite Network Example, Computing Graph Metrics, Les Misérables Co-Appearance Network	**4**
4	**Preparing Data and Filtering-** Serious Eats Network Example, Filtering to Reduce Clutter and Reveal, Important Features Putting It All	**4**

	Together.	
5	**Clustering and Grouping -** The 2007 Senate Voting Analysis, Les Misérables Character Clusters, Federal Communications Commission (FCC), Lobbying Coalition Network	**4**
6	**Email: The Lifeblood of Modern Communication -** Working with Email Data, leaning email Data in NodeXL, Analyzing Personal Email Networks Creating a Living Org-Chart with an Organizational Email Network	**4**
7	**Twitter Conversation, Entertainment, and Information, All in One Network!-** The Nuts and Bolts of Twitter, Networks in Twitter Acquiring Data, Discovery with Twitter	**4**
	Total Lab Hours	**28**

Suggested Text Book(s):

- Hansen, D., Shneiderman, B., and Smith, M.A., 2010. Analyzing social media networks with NodeXL: Insights from a connected world. Morgan Kaufmann.Suggested

Reference Book(s):

- Social Analytics: Network and Text Methods with NodeXL and R.1st Edition by Shaila Miranda and Publisher Prospect Press
- Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing

Online Resources: -

- **https://www.youtube.com/user/brianbritt87/videos**
- **Marc SmithTutorials: https://www.youtube.com/watch?v=TiTxYSqPBaI&list=PL0FBF4A3DCF40BCE2**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO- 11	PO- 12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

COMPUTER ANIMATION

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE: ELECTIVE L-T-P:** 2-0-0

Description

This course investigates the theory, algorithms, and techniques for describing and programming motion for animation worlds. Approaches that will be explored include keyframing systems, kinematics, the motion of articulated figures, and procedural and behavioral systems.

Pre-requisite: Computer Graphics, C

Course Objectives: Students will be able

1. To learn the basic of animation
2. To learn the fundamentals of keyframing and interpolation.
3. To understand the working of motion.
4. To understand animating behavior and articulated figures.
5. To learn the basic principles of motion capture and apply them to an animation application.
6. To understand Human figure study through the anatomy

Course Outcomes

S No	Course Outcomes	Level of Attainment
CO-1	Understand the basic of animation	Familiarity
CO-2	Able to learn the fundamentals of keyframing and interpolation.	Assessment
CO-3	Understand the working of motion	Familiarity
CO-4	Demonstrate the skills for animating behavior and articulated figures	Assessment
CO-5	Able to learn the basic principles of motion capture	Assessment
CO-6	To develop animation application and facial recognition	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction-** Motion perception, Heritage of animation, Animation production, Computer animation production, History of computer animation, **Technical Background-** Spaces and transformations, Orientation representation	4
2	**Interpolating Values-** Interpolation, Controlling the motion of a point along a curve, Interpolation of orientations, Working with paths, **Interpolation-Based Animation-** Key-frame systems, Animation	4

	languages, Deforming objects, Three-dimensional shape interpolation, Morphing (two-dimensional)	
3	**Kinematic Linkages-** Hierarchical modeling, Forward kinematics, Inverse kinematics, **Motion Capture-** Motion capture technologies, Processing the images, Camera calibration, Three-dimensional position reconstruction, Fitting to the skeleton, Output from motion capture systems, Manipulating motion capture data	**5**
4	**Physically Based Animation**- Basic physic, Spring animation examples, Particle systems, Rigid body simulation, Cloth, Enforcing soft and hard constraints, **Fluids-** Liquids and Gases: Specific fluid models, Computational fluid dynamics	**5**
5	**Modeling and Animating Human Figures**- Overview of virtual human representation, Reaching and grasping, Walking, Coverings, **Facial Animation:** Human face, Facial models, Animating the face, Lip-sync animation	**5**
6	**Behavioral Animation-** Primitive behaviors, Knowledge of Environment, Modeling intelligent behavior, Crowds, **Special Models for Animation-** Implicit surfaces, Plants, Subdivision surfaces	**5**
	Total Lecture Hours	**28**

Text Book

- Computer Animation: Algorithms and Techniques, 3rd Edition, by Rick Parent (Morgan Kauffmann, 2012), ISBN: 0124158420

- **Reference Books**
- Foundations of Physically Based Modeling & Animation by Donald H. House and John

B. Keyser CRC Press, 2016, ISBN: 9781482234602

- Physics for Game Developers by David M. Bourg, O'Reilly, 2002, ISBN: 0596000065

Evaluation Scheme:

S No	Exam	Marks	Duration	verage/ Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO- 11	PO- 12	Avg
CO-1	1	1		1	1	1	1	1		1	1		1
CO-2	2	2	2			2		2			2		2
CO-3	3	3	3				3	3					3
CO-4		1	1	1	1			1	1	1	1	1	1
CO-5	3	3		3	3				3	3	3	3	3
CO-6	2		2	2	2	2	2	2	2	2	2	2	2
Avg	2.2	2	2	1.8	1.8	1.7	2	1.8	2	1.8	1.8	2	1.9

COMPUTER ANIMATION LAB

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2

Description

The students will discover the fundamental principles of animation & exploit these fundamental principles to create convincing character motion.

Course Objectives: Students will be able

1. To learn the basic tool of animation
2. To learn the fundamentals of sketching and drawing.
3. To learn the design of animation character.
4. To develop an animation application

Course Outcomes

S No	Course Outcomes	Level of Attainment
CO-1	Capable to work with basic Animator Drawing Tool	Familiarity
CO-2	Demonstrate the skills for sketching and drawing.	Assessment
CO-3	Capable to develop animation character	Assessment
CO-4	Capable to develop animation application	Usage

List of Experiments

S No	Experiment	Hours
1	**Using Animator's Drawing Tools** The Animation Table (lightbox), Field charts, Line Testing Camera, Peg bar, Punching Machine	**4**
2	**Sketching and Drawing** Drawing for Animation, Exercises and Warm-ups on Pegging Sheet, Quick studies from real life, sequential movement drawing, Caricaturing the action, thumbnails drawing for motion	**8**
3	**Developing an Animation Character** Incorporating various moods and shades of a character Various gestures and facial expressions of the character	**8**
4	**Anatomy and Body Language** Front, side and back view of the character, Anatomy and Body Language of the character Caricaturing the character	**8**
	Total Lab Hours	**28**

Textbook

- The complete animation course by Chris Patmore Pub.-Baron's Educational Series (New York)

Reference book

- Animation Unleashed by Ellen Bessen, Michael Weise Productions Pub.2008 (U.S.A)
- The Animator's Survival Kit by Richard Williams, Arrar Straus & Giroux Pub.(U.S.A)

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO-1	1	1		2	1	3	1	1		2	1		1.4
CO-2	2	1	2			2		2		3	2	1	1.9
CO-3	3	2	3		2		2	3			3		2.6
CO-4		1	2	1	3			1	3	2	1	2	1.8
Avg	2	1.3	2.3	1.5	2	2.5	1.5	1.8	3	2.3	1.8	1.5	2