Scheme of

POSTGRADUATE DEGREE COURSE

M.Tech. I to IV Semester

Computer Science and Engineering

(Effective from academic session: 2020-21)

28.06.2020

Rajasthan Technical University, Kota

Akelgarh, Rawatbhata Road, Kota-324010

Teaching & Examination Scheme
M.Tech.: Computer Science and Engineering
1st Year –I Semester

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	1MCS1-01	Statistical Methods in Computer Science	3	0	0	3	30	70	100	3
2	PCC	1MCS1-02	Digital Forensics	3	0	0	3	30	70	100	3
3	PEC	1MCS2-11	Machine Learning	3	0	0	3	30	70	100	3
		1MCS2-12	Security Assessment and Risk Analysis								
		1MCS2-13	Computer Vision								
4	PEC	1MCS2-14	Computational Intelligence	3	0	0	3	30	70	100	3
		1MCS2-15	Malware Analysis & Reverse Engineering								
		1MCS2-16	Data Preparation and Analysis								
5	MCC	1MCC3-21	Research Methodology and IPR	2	0	0	2	30	70	100	2
6	PCC	1MCS1-06	IoT Based Systems Design Lab	0	0	4	4	60	40	100	2
7	PCC	1MCS1-07	Network Simulation and Security Analysis Lab	0	0	4	4	60	40	100	2
8	SODECA	1MCS5-00	Social Outreach Discipline & Extra Curriculum Activities							100	0.5
			Total	**14**	**0**	**8**		**270**	**430**	**800**	**18.5**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*

Office of Dean Academic Affairs
Rajasthan Technical University, Kota

Teaching & Examination Scheme
M.Tech.: Computer Science and Engineering
1st Year – II Semester

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	2MCS1-01	Data Science	3	0	0	3	30	70	100	3
2	PCC	2MCS1-02	Distributed and Parallel Algorithms	3	0	0	3	30	70	100	3
3	PEC	2MCS2-11	Big Data Analytics	3	0	0	3	30	70	100	3
		2MCS2-12	Data Security and Access Control								
		2MCS2-13	Data Storage Technologies and Networks								
4	PEC	2MCS2-14	Knowledge Discovery	3	0	0	3	30	70	100	3
		2MCS2-15	Secure Software Design and Enterprise Computing								
		2MCS2-16	Wireless Sensor Networks								
5	MCC	2MCC3-XX	Audit Course-I	2	0	0	2	30	70	100	0
6	PCC	2MCS1-06	High Performance Computing Lab	0	0	4	4	60	40	100	2
7	PCC	2MCS1-07	Data Analytics Lab	0	0	4	4	60	40	100	2
8	REW	2MCS4-50	Mini Project with Seminar	0	0	4	4	60	40	100	2
9	SODECA	2MCS5-00	Social Outreach Discipline & Extra Curriculum Activities							100	0.5
			Total	14	0	12		300	400	800	**18.5**

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ETE: *End Term Exam,* ***IA:*** *Internal Assessment*

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Teaching & Examination Scheme
M.Tech.: Computer Science and Engineering
2nd Year – III Semester

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PEC	3MCS2-01	Business Intelligence	3	0	0	3	30	70	100	3
		3MCS2-02	Block-Chain Technologies								
		3MCS2-03	Social Network Analysis								
2	MCC	3MCC3-XX	Open Elective	3	0	0	3	30	70	100	3
3	MCC	3MCC3-XX	Audit Course-II	2	0	0	2	30	70	100	0
4	REW	3MCS4-60	Dissertation-I / Industrial Project	0	0	x		240	160	400	10
			Total	6	0			300	300	600	**16**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*

**: Not to be considered for award of divison*

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Teaching & Examination Scheme
M.Tech.: Computer Science and Engineering
2nd Year – IV Semester

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	REW	4MCS4-70	Dissertation-II	0	0	x		360	240	600	16
			Total	0	0			360	240	600	**16**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*

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1MCS1-01: Statistical Methods in Computer Science

Core Subjects:

Course Code	
Course Name	**Statistical Methods in Computer Science**
Credits	3
Pre-Requisites	Discrete Mathematics

Total Number of Lectures:40

COURSE OBJECTIVE
• To understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
• To develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.
• To study various sampling and classification problems.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1 Introduction: Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains	6
Unit 2 Sampling: Random samples, sampling distributions of estimators**,** Methods of Moments and Maximum Likelihood**,**	4
Unit 3 Introduction to multivariate statistical models: Statistical inference**,** Introduction to multivariate statistical models: regression and classification problems, principal components analysis**,** The problem of overfitting model assessment.	5
Unit 4 Graph Theory: Isomorphism, Planar graphs, graph colouring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems.	10
Unit 5 Computer science and engineering applications: Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.	10
Unit 6 Recent Trends: Recent Trends various distribution functions in mathematical field of computer science for varying fields like bioinformatic, soft computing, and computer vision.	5

References:

1. John Vince, Foundation Mathematics for Computer Science, Springer.
2. K. Trivedi Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.

3. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
4. Alan Tucker, Applied Combinatorics, Wiley
5. An Introduction to Statistical. Learning. Gareth James. Daniela Witten. Trevor Hastie.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Statistical Methods in Computer Science	**CO 1**	To understand the basic notions of discrete and continuous probability.
		CO 2	To understand the methods of statistical inference, and the role that sampling distributions play in those methods.
		CO 3	To be able to perform correct and meaningful statistical analyses of simple to moderate complexity.

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1MCS1-02: Digital Forensics

Course Code	
Course Name	Digital Forensics
Credits	3
Pre-Requisites	Cybercrime and Information Warfare, Computer Networks

Total Number of Lectures: 40

COURSE OBJECTIVE
• Provides an in-depth study of the rapidly changing and fascinating field of computer forensics.
• Combines both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
• Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools
• E-evidence collection and preservation, investigating operating systems and file systems, network forensics, art of steganography and mobile device forensics

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Digital Forensics Science: Forensics science, computer forensics, and digital forensics. **Computer Crime:** Criminalistics as it relates to the investigative process, analysis of cyber-criminalistics area, holistic approach to cyber-forensics	7
Unit 2: Cyber Crime Scene Analysis: Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation.	7
Unit 3: Evidence Management & Presentation: Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, explain what the normal case would look like, define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.	7
Unit 4: Computer Forensics: Prepare a case, begin an investigation, understand computer forensics workstations and software, conduct an investigation, complete a case, Critique a case. **Network Forensics:** open-source security tools for network forensic analysis, requirements for preservation of network data.	8
Unit 5: Mobile Forensics: mobile forensics techniques, mobile forensics tools. **Legal Aspects of Digital Forensics:** IT Act 2000, amendment of IT Act 2008.	7
Unit 6: Recent Trends: Recent Trends Mobile forensic technique and methods to search and seizure electronic evidence.	4

References:

1. John Sammons, The Basics of Digital Forensics, Elsevier

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2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications
3. A Practical Guide to Digital Forensics Investigations Darren R. Hayes.
4. Digital Forensics and Incident Response Incident response techniques and procedures to respond to modern cyber threats, 2nd Edition Gerard Johansen.
5. B. Nelson, A. Phillips, F Enfinger, C Steuart, Guide to Computer Forensics and Investigations, 4th Edition, Course Technology, 2010

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Digital Forensics	**CO 1**	Understand relevant legislation and codes of ethics
		CO 2	Computer forensics and digital detective and various processes, policies and procedures
		CO 3	E-discovery, guidelines and standards, E-evidence, tools and environment.
		CO 4	Email and web forensics and network forensics

1MCS2-11: Machine learning

Course Code	
Course Name	Machine learning
Credits	3
Pre-Requisites	

Total Number of Lectures:40

COURSE OBJECTIVE
• To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
• To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
• Explore supervised and unsupervised learning paradigms of machine learning.
• To explore advance Machine learning techniques and various feature extraction strategies.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Supervised Learning (Regression/Classification):** • Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes • Linear models: Linear Regression, Logistic Regression, Generalized Linear Models • Support Vector Machines, Nonlinearity and Kernel Methods • Beyond Binary Classification: Multi-class/Structured Outputs, Ranking	10
Unit 2: **Unsupervised Learning:** • Clustering: K-means/Kernel K-means • Dimensionality Reduction: PCA and kernel PCA • Matrix Factorization and Matrix Completion • Generative Models (mixture models and latent factor models)	5
Unit 3 **Machine Learning Algorithm and Models:** Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)	5
Unit 4 **Modelling in Machine Learning:** Sparse Modelling and Estimation, Modelling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning.	6
Unit 5 **Advanced Topics in Machine Learning:** Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference	9
Unit 6: **Recent trends:** Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.	5

References:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4. Tom Mitchel, Machine Learning, McGraw Hill Science, 1997
5. G. James, D. Witten, T. Hastie, R. Tibshirani, An introduction to statistical learning with applications in R, Springer, 2013.
6. Wasserman, All of Statistics, 1 st Edition, Springer, 2004

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Machine learning	**CO 1**	Extract features that can be used for a particular machine learning approach in various IOT applications.
		CO 2	To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
		CO 3	To mathematically analyse various machine learning approaches and paradigms.

1MCS2-12: Security Assessment and Risk Analysis

Course Code	
Course Name	Security Assessment and Risk Analysis
Credits	3
Pre-Requisites	Computer and Network Security

Total Number of Lectures:40

COURSE OBJECTIVE
• Describe the concepts of risk management
• Define and differentiate various Contingency Planning components
• Integrate the IRP, DRP, and BCP plans into a coherent strategy to support sustained organizational operations.
• Define and be able to discuss incident response options, and design an Incident Response Plan for sustained organizational operations.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: SECURITY BASICS: Information Security (INFOSEC) Overview: critical information characteristics – availability information states – processing security counter measures education, training and awareness, critical information characteristics – confidentiality critical information characteristics – integrity, information states – storage, information states – transmission, security counter measures policy, procedures and practices, threats, vulnerabilities.	7
Unit 2: Threats to and Vulnerabilities of Systems: Definition of terms (e.g., threats, vulnerabilities, risk), major categories of threats (e.g., fraud, Hostile Intelligence Service (HOIS), malicious logic, hackers, environmental and technological hazards, disgruntled employees, careless employees, HUMINT, and monitoring), threat impact areas, Countermeasures: assessments (e.g., surveys, inspections), Concepts of Risk Management: consequences (e.g., corrective action, risk assessment), cost/benefit analysis of controls, implementation of cost-effective controls, monitoring the efficiency and effectiveness of controls (e.g., unauthorized or inadvertent disclosure of information), threat and vulnerability assessment	7
Unit 3: Security Planning: Directives and procedures for policy mechanism, Risk Management: acceptance of risk (accreditation), corrective actions information identification, risk analysis and/or vulnerability assessment components, risk analysis results evaluation, roles and responsibilities of all the players in the risk analysis process, Contingency Planning/Disaster Recovery: agency response procedures and continuity of operations, contingency plan components, determination of backup requirements, development of plans for recovery actions after a disruptive event, development of procedures for offsite processing, emergency destruction procedures, guidelines for determining critical and essential workload, team member responsibilities in responding to an emergency situation	8
Unit 4: POLICIES AND PROCEDURES: Physical Security Measures: alarms, building construction, cabling,	8

communications centre, environmental controls (humidity and air conditioning), filtered power, physical access control systems (key cards, locks and alarms) Personnel Security Practices and Procedures: access authorization/verification (need to know), contractors, employee clearances, position sensitivity, security training and awareness, systems maintenance personnel, Administrative Security Procedural Controls: attribution, copyright protection and licensing , Auditing and Monitoring: conducting security reviews, effectiveness of security programs, investigation of security breaches, privacy review of accountability controls, review of audit trails and logs	
Unit 5: Operations Security (OPSEC): OPSEC surveys/OPSEC planning INFOSEC: computer security – audit, cryptography encryption (e.g., point to point, network, link), cryptography key management (to include electronic key), cryptography strength (e.g., complexity, secrecy, characteristics of the key)	8
Unit 6: Case study of threat and vulnerability assessment	2

References:

1. Principles of Incident Response and Disaster Recovery, Whitman & Mattord, Course Technology ISBN: 141883663X
2. Security Risk Assessment 1st Edition John White
3. Information Security Risk Analysis Thomas R. Peltier
4. (Web Link) http://www.cnss.gov/Assets/pdf/nstissi_4011.pdf

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Security Assessment and Risk Analysis	**CO 1**	Capable of recommending contingency strategies including data backup and recovery and alternate site selection for business resumption planning
		CO 2	Skilled to be able to describe the escalation process from incident to disaster in case of security disaster.
		CO 3	Capable of Designing a Disaster Recovery Plan for sustained organizational operations.
		CO 4	Capable of Designing a Business Continuity Plan for sustained organizational operations.

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1MCS2-13: Computer Vision

Course Code	
Course Name	Computer Vision
Credits	3
Pre-Requisites	Linear algebra, vector calculus, Data structures and Programming.

Total Number of Lectures: 40

COURSE OBJECTIVE
• Be familiar with both the theoretical and practical aspects of computing with images.
• Have described the foundation of image formation, measurement, and analysis.
• Understand the geometric relationships between 2D images and the 3D world.
• Grasp the principles of state-of-the-art deep neural networks.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Overview: computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis	6
Unit 2: Image Detection: Edge detection, Edge detection performance, Hough transform, corner detection	5
Unit 3: Segmentation, Morphological filtering, Fourier transform.	5
Unit 4: Image Features: Feature extraction, shape, histogram, color, spectral, texture, using CVIPtools, Feature analysis, feature vectors, distance /similarity measures, data pre processing	10
Unit 5: Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians Classification: Discriminant Function, Supervised, Un-supervised, Semi supervised Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA, and Non-parametric methods.	10
Unit 6: Recent trends in Activity Recognition, computational photography, Biometrics.	4

References:

1. Computer Vision: Algorithms and Applications by Richard Szeliski.
2. Deep Learning, by Goodfellow, Bengio, and Courville.
3. Dictionary of Computer Vision and Image Processing, by Fisher et al.
4. Computer Vision: Models, Learning, and Inference by Simon Prince
5. Computer Vision: A Modern Approach by David Forsyth and Jean Ponce
6. Recent Trends in Image and Signal Processing in Computer Vision Shruti Jain, Sudip Paul
7. Deep Learning in Computer Vision Principles and Applications Mahmoud Hassaballah, Ali Ismail Awad
8. Modern Deep Learning and Advanced Computer Vision A Perspective Approach Dr.P.S.Jagadeesh Kumar, Prof. Thomas Binford, Dr.J. Ruby, J. Lepika

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Computer Vision	**CO 1**	Developed the practical skills necessary to build computer vision applications.
		CO 2	To have gained exposure to object and scene recognition and categorization from images.

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1MCS2-14: Computational Intelligence

Course Code	
Course Name	Computational Intelligence
Credits	3
Pre-Requisites	Basic knowledge of Data structure, programming.

Total Number of Lectures: 40

COURSE OBJECTIVE
• To understand the various concepts of Computational Intelligence Techniques.
• To enable Problem-solving through various searching techniques.
• Knowledge enhancement to design the intelligent techniques.
• Practical knowledge of the computational techniques on complex problems of discrete and continues nature.
• To apply these techniques in applications which involve perception, reasoning and Learning.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Computational Intelligence: Computational Intelligence Paradigms, Introduction to Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design.	7
Unit 2: Artificial neural networks: Artificial Neuron, Supervised Learning Neural Networks, Unsupervised Learning Neural Networks, Performance Issues (Supervised Learning), Performance Measures, Accuracy, Complexity, Convergence.	7
Unit 3: Evolutionary computation: Introduction to Evolutionary Computation, Genetic Algorithms: Crossover, mutation, selection, Differential evolution algorithm, Hybrid Differential Evolution Strategies, Differential Evolution for Discrete-Valued Problems**.**	7
Unit 4: Multi-objective Optimization Problem Solving: Concept of multi-objective optimization problems (MOOPs) and issues of solving them, Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto- based approaches to solve MOOPs, Some applications with MOEAs.	9
Unit 5: Applications of computational intelligent techniques: In solving single- objective and multi-objective optimization, scheduling problem, Parameter Estimation for Frequency-Modulated (FM) Sound Waves, Lennard-Jones Potential Problem, Gear Train Problem, Pressure vessel optimization problem, Welded beam design optimization problem	10

References:

1. A. P. Engelbrecht, Computational Intelligence: An Introduction, John Wiley & Sons, 2007.
2. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey, 2010.
3. X. Yu and M. Gen, Introduction to Evolutionary Algorithms, Springer Verlag, 2010.
4. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.

5. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Computational Intelligence	**CO 1**	Learn Fuzzy logic and its applications.
		CO 2	Provide a basic exposition to the goals and methods of Computational Intelligence.
		CO 3	Study of the design of intelligent computational techniques.
		CO 4	Able to solve single-objective optimization problems using Genetic and Differential Evolution algorithms.
		CO 5	Able to solve multi-objective optimization problems using Genetic and Differential Evolution algorithms.

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1MCS2-15: Malware Analysis and Reverse Engineering

Course Code	
Course Name	Malware Analysis and Reverse Engineering
Credits	3
Pre-Requisites	

Total Number of Lectures: 40

COURSE OBJECTIVE
• The objective of this course is to provide an insight to fundamentals of malware analysis which includes analysis of JIT compilers for malware detection in legitimate code. DNS filtering and reverse engineering is included.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Malware Analysis: Fundamentals of Malware Analysis (MA), Reverse Engineering Malware (REM) Methodology, Brief Overview of Malware analysis lab setup and configuration, Introduction to key MA tools and techniques, Behavioral Analysis vs. Code Analysis, Resources for Reverse-Engineering Malware (REM) Understanding Malware Threats, Malware indicators, Malware Classification, Examining Clam AV Signatures, Creating Custom Clam AV Databases, Using YARA to Detect Malware Capabilities, Creating a Controlled and Isolated Laboratory, Introduction to MA Sandboxes, Ubuntu, Zeltser'sREMnux, SANS SIFT, Sandbox Setup and Configuration New Course Form, Routing TCP/IP Connections, Capturing and Analyzing Network Traffic, Internet simulation using INetSim, Using Deep Freeze to Preserve Physical Systems, Using FOG for Cloning and Imaging Disks, Using MySQL Database to Automate FOG Tasks, Introduction to Python ,Introduction to x86 Intel assembly language, Scanners: Virus Total, Jotti, and No Virus Thanks, Analyzers: Threat Expert, CW Sandbox, Anubis, Joebox, Dynamic Analysis Tools: Process Monitor, Regshot, HandleDiff, Analysis Automation Tools: Virtual Box, VM Ware, Python , Other Analysis Tools	10
Unit 2: Malware Forensics: Using TSK for Network and Host Discoveries, Using Microsoft Offline API to Registry Discoveries, Identifying Packers using PEiD, Registry Forensics with Reg Ripper Plugins, Bypassing Poison Ivy's Locked Files, Bypassing Conficker's File System ACL Restrictions, Detecting Rogue PKI Certificates.	5
Unit 3: Malware and Kernel Debugging: Opening and Attaching to Processes, Configuration of JIT Debugger for Shellcode Analysis, Controlling Program Execution, Setting and Catching Breakpoints, Debugging with Python Scripts and Py Commands**,** DLL Export Enumeration, Execution, and Debugging**,** debugging a VMware Workstation Guest (on Windows)**,** Debugging a Parallels Guest (on Mac OS X). Introduction to WinDbg Commands and Controls, Detecting Rootkits with WinDbg Scripts**,** Kernel Debugging with IDA Pro.	6
Unit 4: Memory Forensics and Volatility: Memory Dumping with MoonSols Windows Memory Toolkit**,** Accessing VM Memory Files Overview of Volatility, Investigating Processes in Memory	7

Dumps, Code Injection and Extraction, Detecting and Capturing Suspicious Loaded DLLs, Finding Artifacts in Process Memory, Identifying Injected Code with Malfind and YARA.	
Unit 5: Researching and Mapping Source Domains/Ips: Using WHOIS to Research Domains, DNS Hostname Resolution, Querying Passive DNS, Checking DNS Records, Reverse IP Search New Course Form, Creating Static Maps, Creating Interactive Maps.	7
Unit 6: Case Study: Case study of Finding Artifacts in Process Memory, Identifying Injected Code with Malfind and YARA	5

References:

1. Michael Sikorski, Andrew Honig "Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software" publisher Williampollock.
2. Practical Malware Analysis – The Hands–On Guide to Dissecting Malicious Software by Michael Sikorski and Andrew Honig.
3. Mastering Malware Analysis: The complete malware analyst's guide to combating malicious software, APT, cybercrime, and IoT attacks 1st Edition by Alexey Kleymenov and Amr Thabet.
4. Advanced Malware Analysis by Christopher Elisan

Course Outcome:

Course Code	Course Name	Course Outcome	Details
1MCS2-15	Malware Analysis and Reverse Engineering	**CO 1**	To understand the concept of malware and reverse engineering.
		CO 2	Implement tools and techniques of malware analysis.

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1MCS2-16: Data Preparation and Analysis

Course Code	
Course Name	Data Preparation and Analysis
Credits	3
Pre-Requisites	

Total Number of Lectures: 40

COURSE OBJECTIVE
• To prepare the data for analysis and develop meaningful Data Visualizations

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit1: Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues	10
Unit2: Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation	10
Unit3: Exploratory Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis generation	10
Unit4: Visualization: Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity	10

References:

1. Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn J. Myatt
2. Data Preparation for Data Mining (The Morgan Kaufmann Series in Data Management Systems) by Dorian Pyle
3. Principles of Data Wrangling: Practical Techniques for Data Preparation by Tye Rattenbury, Joseph M. Hellerstein, Jeffrey Heer, Sean Kandel, Connor Carreras.
4. Introduction to Data Mining by Pang-Ning Tan, Michael Steinbach.
5. Data Mining: Concepts and Techniques Jiawei Han

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Data Preparation and Analysis	**CO 1**	Able to extract the data for performing the Analysis.

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1MCS1-06: IoT Based Systems Design Lab

1. Calibration and accessing real-time sensors data
   (i) Accessing and observing inertial sensors' data
   (ii) Updating sensors' parameters and observing the impact
   (iii) Calibrating multi-IMU system and calibration compensation with WiFi
   (iv) Gaining familiarity with an IoT Sensor
2. Connecting smart IoT sensor with cloud (Firebase Integration with Python)
3. Firmware Modification & Compilation, USB Boot loading and Clock Budgeting
   (i) Understanding structure of Atmel Studio.
   (ii) Gaining some insight of oblu's firmware. And making minor modifications. Generating hex file (i.e. compiling the f/w) and boot loading it into oblu over USB.
   (iii) Experimenting to understand concept of clock budgeting in embedded design.
4. Getting Familiar with Raspberry Pi 3

Ref: https://karkare.github.io/cs664/

1MCS1-07: Network Simulation and Security Analysis Lab

A. Network Simulation

The students shall be exposed to simulation tools like NS3 and new platforms like SDN. All the tools are freely available. For SDN, OpenFlow is recommended platform

Suggested Exercises:

1. Simulate State Vector Routing/ Bellman Ford Algorithm on NS3.
2. Simulate a routing algorithm for WSN/MANET reported recently in the literature.
3. Create a routing table for a 4-5 node SDN with one controller.
4. Repeat the exercise for a two controller SDN network with 8-10 nodes.

B. Security Analysis

For this lab, 15 desktop systems and one server system (2 NIC) connected in LAN, with Linux and Windows on Desktop are suggested. These will be disconnected from the rest of the institute LAN. Having 15 systems will allow the lab to be used for UG programs as well. A group of 2 students (4 in case of UG) will be formed.

Each group will have access to only one system directly and will be using it to target the other systems in the LAN.

Each group will use freely available Security tools to make its system secure. Once done, each group will offer its system for attack by another group. The attacker group will need to use tools (Freeware) to find the vulnerabilities and exploit them for attacking.

each group must install, configure, and make available the following services:

- A web server – groups are encouraged to customize the page(s) with identifying information such as member names and pictures.
- An FTP server, which allows anonymous FTP access to some token files.
- An SSH server – for remote access to the machine.
- A MySQL server – the database should allow client connections from the server console and remote clients. A sample database with some data records should also be created.

The attacker group will perform the following tasks:

A. Network Based Attacks:

- The group will attempt to exploit vulnerabilities discovered on the target system.
- Once the system has been compromised, the group should create a file on the system containing the names of the group indicating the successful exploit.
- The group should immediately contact the instructor about the success of the attack, and upon confirmation should continue with the Local Attack.
- If all of the attack vectors that have been attempted were unsuccessful in compromising the system remotely, then the group should contact the lab administrator for credentials to continue with the Local Attack.

B. Local Attacks:

- The instructor will create an unprivileged account on the target client for each group.
- The group will attempt to gain root/administrator access on the target system, and leave a mark in the /root/ directory (for Linux targets) or the /Documents and Settings/Administrator/ (for

Windows targets). The group should immediately contact the instructor about the success of the attack.

- A group is not allowed to disturb the target any more than is necessary, for the sake of other groups that may also be attempting to compromise the same system.

The report shall have two parts.

A. Configuration Report
   - What steps were taken to secure the system, and why they were performed?
   - Any additional software that was installed, and why. It is not required to include an itemized list of updated packages. Students just need to mention completely new software such as network diagnostic or security tools.
   - Problems encountered with their system in general and the setup steps specifically

B. Attack Report
   - A description of what attacks were attempted, and the result of each attack (for both Network and Local attacks) even if unsuccessful.
   - The location and content of the files created by the group left on the target system after each successful attack.
   - A review of how 'noisy' the attacks were. In other words, how likely would it have been that a system administrator would have noticed the attack before or after the compromise
   - If the attack(s) were unsuccessful, report on why this was so and discuss what further attacks might be tried or extended.
   - A conclusion to the overall exercise, including what the group has learned and how they might do things differently in the future. It is also encouraged to provide thoughts about how the vulnerabilities exploited might influence the setup and maintenance of the group's own machine.

Ref:

Yu, Yingbing. "Designing hands-on lab exercises in the network security course." *Journal of Computing Sciences in Colleges* 22.5 (2007): 105-110.

2MCS1-01: Data Science

Course Code	
Course Name	Data Science
Credits	3
Pre-Requisites	

Total Number of Lectures:40

COURSE OBJECTIVE

• Provide you with the knowledge and expertise to become a proficient data scientist.
• Demonstrate an understanding of statistics and machine learning concepts that are vital for data science.
• Produce Python code to statistically analyse a dataset.
• Critically evaluate data visualisations based on their design and use for communicating stories from data.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.	5
Unit 2: Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources	5
Unit 3: Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.	10
Unit 4: Data visualisation: Introduction, Types of data visualisation, Data for visualisation: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.	10
Unit 5: Applications of Data Science: Applications of Data Science, Technologies for visualisation, Bokeh (Python)	5
Unit 6: Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.	5

References:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly.
2. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.
3. The Art of Data Science by Roger D. Peng and Elizabeth Matsui
4. Practical Statistics for Data Scientists — by Peter Bruce

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Data Science	**CO 1**	Explain how data is collected, managed and stored for data science.
		CO 2	Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists.
		CO 3	Implement data collection and management scripts using MongoDB.

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2MCS1-02: Distributed and Parallel Algorithms

Course Code	
Course Name	Distributed and Parallel Algorithms
Credits	3
Pre-Requisites	

Total Number of Lectures: 40

COURSE OBJECTIVE
• To acquaint students with the with the basic concepts of parallel and distributed computing.
• Detailed understanding of the synchronous and asynchronous distributed network models.
• Knowledge enhancement on the Asynchronous algorithms.
• To study parallel algorithms for basic problems.
• Analyze efficiency and complexity of the different parallel algorithms.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: Introduction of the synchronous and asynchronous distributed network models, failures, input-output and the execution of the models.	3
Unit 2: Distributed Algorithms: Leader election in a synchronous ring, Basic, Hirschberg-Sinclare, Time- Slice & Variable-Speed algorithms. Distributed algorithms in General Synchronous Networks, LubyMIS algorithm. Distributed Consensus with Link failures, Deterministic & Randomized algorithms. Distributed Consensus with Process failures, EIG algorithm for Byzantine failures, algorithms for commit problems.	9
Unit 3: Asynchronous shared memory algorithms, Lockout-free algorithms, Tournament algorithm, Bakery BurnsME algorithms. QueueME, TicketME, BufferMainME, ExecutiveME etc.	8
Unit 4: Transformations from shared memory model to network model and vice- versa. Failure Detectors.	5
Unit 5: Overview of Parallelism: Need for Parallel Processing, Models of Computation -RAM and PRAM Model, Shared Memory and Message Passing Models, Processor Organisations, PRAM Algorithm, Analysis of PRAM Algorithms, Parallel Programming Languages. PRAM Model of Parallel Computation, Parallel algorithm for Divide-and-Conquer, Sequential Subsets & Brent's theorem, Recursive Doubling, Parallel algorithms for merging and sorting, Parallel algorithm for finding diameter of a convex polygon.	8
Unit 6: PRAM Algorithms: Parallel Reduction, Prefix Sums, List Ranking, Preorder Tree Traversal, Merging Two Sorted Lists, Graph Coloring.	7

References:

1. Nancy A. Lynch, and Boaz Patt-Shamir, "Distributed Algorithms," Pearson Education, India, 2002.
2. Algorithm Design: Foundations, Analysis and Internet Examples by M.T. Goodrich & R. Tamassia; John Wiley & Sons.
3. Gerlad Tel, "Introduction to Distributed Algorithms" Cambridge University Press.
4. Michael J. Quinn, "Parallel Computing: Theory & Practice", Tata McGraw Hill Edition, Second edition, 2017.
5. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", University press, Second edition , 2011.
6. V Rajaraman, C Siva Ram Murthy, " Parallel computers- Architecture and Programming ", PHI learning, 2016.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Distributed and Parallel Algorithms	**CO 1**	Identify the advantages and challenges in designing distributed algorithms for different primitives like mutual exclusion, deadlock detection, agreement, etc.
		CO 2	The students will be able to select correct parallel and distributed algorithm and applications.
		CO 3	The students will be able to use synchronization mechanisms properly.
		CO 4	The student will be able to analyze different algorithms and techniques for the design and development of distributed systems subject to specific design and performance constraints.

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2MCS2-11: Big Data Analytics

Course Code	
Course Name	Big Data Analytics
Credits	3
Pre-Requisites	

Total Number of Lectures: 40

COURSE OBJECTIVE
• Understand big data for business intelligence. Learn business case studies for big data analytics.
• Understand NoSQL big data management.
• Perform map-reduce analytics using Hadoop and related tools.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.	7
Unit 2: Database Design: Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schema less databases, materialized views, distribution models, sharding, master-slave replication, peer peer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.	7
Unit 3: HDFS (Hadoop distributed file system): Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures	7
Unit 4: MapReduce: MapReduce workflows, unit tests with MR Unit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats	7
Unit 5: Data Model and Implementations: HBase, data model and implementations, HBase clients, HBase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration.	7
Unit 6: Overview of Pig and HiveQL: Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.	5

References:

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging
2. Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
3. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
4. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
5. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
6. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
7. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
8. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
9. Alan Gates, "Programming Pig", O'Reilley, 2011.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Big Data Analytics	**CO 1**	Describe big data and use cases from selected business domains
		CO 2	Explain NoSQL big data management
		CO 3	Install, configure, and run Hadoop and HDFS
		CO 4	Perform map-reduce analytics using Hadoop
		CO 5	Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics

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2MCS2-12: Database Security and Access Control

Course Code	
Course Name	Database Security and Access Control
Credits	3
Pre-Requisites	Database Management

Total Number of Lectures: 40

COURSE OBJECTIVE
• The objective of the course is to provide fundamentals of database security. Various access control techniques mechanisms were introduced along with application areas of access control techniques.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: Introduction to Access Control, Purpose and fundamentals of access control, brief history.	5
Unit 2: Access Controls: Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non- Discretionary Access Control, Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations.	6
Unit 3: Role Based Access Control (RBAC): Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy.	6
Unit 4: Models: Biba's intrigity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system, Temporal Constraints in RBAC, MAC AND DAC. Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multi line Insurance Company.	10
Unit 5: Introduction to Smart Card based Information: Smart Card based Information Security, Smart card operating system fundamentals, design and implantation principles, memory organization, smart card files, file management, atomic operation, smart card data transmission ATR, PPS Security techniques- user identification, smart card security, quality assurance and testing, smart card life cycle-5 phases, smart card terminals.	10
Unit 6: Recent Trends: Recent trends in Database security and access control mechanisms. Case study of Role-Based Access Control (RBAC) systems.	3

References:

1. Role Based Access Control: David F. Ferraiolo, D. Richard Kuhn, Ramaswamy Chandramouli.
2. http://www.smartcard.co.uk/tutorials/sct-itsc.pdf : Smart Card Tutorial.
3. Access Control Systems: Security, Identity Management and Trust Models by Messaoud Benantar
4. Database Security by Alfred Basta, Melissa Zgola.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Database Security and Access Control	**CO 1**	In this course, the students will be enabled to understand and implement classical models and algorithms.
		CO 2	They will learn how to analyze the data, identify the problems, and choose the relevant models and algorithms to apply.
		CO 3	They will further be able to assess the strengths and weaknesses of various access control models and to analyze their behaviour.

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2MCS2-13: Data Storage Technologies and Networks

Course Code	
Course Name	Data Storage Technologies and Networks
Credits	3
Pre-Requisites	Basic knowledge of Computer Architecture, Operating Systems, and Computer Networking is required.

Total Number of Lectures: 40

COURSE OBJECTIVE
• To provide learners with a basic understanding of Enterprise Data Storage and Management Technologies

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Storage Media and Technologies: Magnetic, Optical and Semiconductor Media, Techniques for read/write Operations, Issues and Limitations.	7
Unit 2: Usage and Access: Positioning in the Memory Hierarchy, Hardware and Software Design for Access, Performance issues.	8
Unit 3: Large Storages: Hard Disks, Networked Attached Storage, Scalability issues, Networking issues.	6
Unit 4: Storage Architecture: Storage Partitioning, Storage System Design, Caching, Legacy Systems.	8
Unit 5: Storage Area Networks: Hardware and Software Components, Storage Clusters/Grids. **Storage QoS**–Performance, Reliability, and Security issues.	8
Unit 6: **Recent Trends** related to Copy data management, Erasure coding, and Software defined storage appliances.	3

References:

1. The Complete Guide to Data Storage Technologies for Network-centric Computing Paperback– Import, Mar 1998 by Computer Technology Research Corporation
2. Data Storage Networking: Real World Skills for the CompTIA Storage by Nigel Poulton
3. Security and Data Storage Aspect in Cloud Computing (Studies in Big Data) by Prachi S. Deshpande, Subhash C. Sharma, Sateesh K. Peddoju.
4. Data Deduplication for Data Optimization for Storage and Network Systems by Daehee Kim, Sejun Song, Baek-Young Choi.
5. Big Data: Storage, Sharing, and Security by Fei Hu.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Data Storage Technologies and Networks	**CO 1**	Learn Storage System Architecture
		CO 2	Overview of Virtualization Technologies, Storage Area Network

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2MCS2-14: Knowledge Discovery

Course Code	
Course Name	Knowledge Discovery
Credits	3
Prerequisites	

Total Number of Lectures: 40

COURSE OBJECTIVE
• Conduct case studies on real data mining examples

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction KDD and Data Mining: Data Mining and Machine Learning, Machine Learning and Statistics, Generalization as Search, Data Mining and Ethics	5
Unit 2: Knowledge Representation: Decision Tables, Decision Trees, Classification Rules, Association Rules, Rules involving Relations, Trees for Numeric Predictions, Neural Networks, Clusters	7
Unit 3: Decision Trees: Divide and Conquer, Calculating Information, Entropy, Pruning, Estimating Error Rates, The C4.5 Algorithm. **Evaluation of Learned Results**- Training and Testing, Predicting Performance, Cross-Validation.	8
Unit 4: Classification Rules: Inferring Rudimentary Rules, Covering Algorithms for Rule Construction, Probability Measure for Rule Evaluation, Association Rules, Item Sets, Rule Efficiency	8
Unit 5: Numeric Predictions: Linear Models for Classification and Numeric Predictions, Numeric Predictions with Regression Trees, Evaluating Numeric Predictions	7
Unit 6: Artificial Neural Networks: Perceptron's, Multilayer Networks, The Backpropagation Algorithm **Clustering** - Iterative Distance-based Clustering, Incremental Clustering, The EM Algorithm	5

References:

1. Data mining and knowledge discovery handbook by Maimon, oded(et al.)
2. Data Cleansing: A Prelude to knowledge Discovery
3. Knowledge Discovery and Data Mining: Challenges and Realities by Xingquan Zhu, Ian Davidson
4. Data Mining and Knowledge Discovery Handbook (Springer series in solid-state sciences) by Oded Maimon, Lior Rokach
5. Data Mining and Knowledge Discovery Technologies by David Taniar

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Knowledge Discovery	**CO 1**	Able to have knowledge of various knowledge representation methods.

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2MCS2-15: Secure Software Design and Enterprise Computing

Course Code	
Course Name	Secure Software Design and Enterprise Computing
Credits	3
Pre-Requisites	Computer Programming, Software Engineering

Total Number of Lectures:40

COURSE OBJECTIVE
• To fix software flaws and bugs in various software.
• To make students aware of various issues like weak random number generation, information leakage, poor usability, and weak or no encryption on data traffic
• Techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment.
• Methodologies and tools to design and develop secure software containing minimum vulnerabilities and flaws.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Secure Software Design: Identify software vulnerabilities and perform software security analysis, Master security programming practices, Master fundamental software security design concepts, Perform security testing and quality assurance.	7
Unit 2: Enterprise Application Development: Describe the nature and scope of enterprise software applications, Design distributed N-tier software application, Research technologies available for the presentation, business and data tiers of an enterprise software application, Design and build a database using an enterprise database system, Develop components at the different tiers in an enterprise system, Design and develop a multi-tier solution to a problem using technologies used in enterprise system, Present software solution.	7
Unit 3: Enterprise Systems Administration: Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment, Monitor server resource utilization for system reliability and availability, Install and administer network services (DNS/DHCP/Terminal Services/Clustering/Web/Email).	7
Unit 4: Manage and Troubleshoot A Network: Obtain the ability to manage and troubleshoot a network running multiple services, Understand the requirements of an enterprise network and how to go about managing them.	7
Unit 5: Insecure Exceptions and Command/SQL Injection: Handle insecure exceptions and command/SQL injection, defend web and mobile applications against attackers, software containing minimum vulnerabilities and flaws.	8
Unit 6: Case Study: Case study of DNS server, DHCP configuration and SQL injection attack.	4

References:

1. Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett
2. Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software Security, Addison Wesley
3. Gary McGraw, Software Security: Building Security In, Addison-Wesley, 2006

Text Books:

1. W. Stallings, Cryptography and network security: Principles and practice, 5 th Edition, Upper Saddle River, NJ: Prentice Hall., 2011
2. C. Kaufman, r. Perlman, & M. Speciner, Network security: Private communication in a public world, 2 nd Edition, Upper Saddle River, NJ:Prentice HallL, 2002
3. C. P. Pfleeger, S. L. Pfleeger, Security in Computing, 4 th Edition, Upper Saddle River, NJ:Prentice Hall, 2007
4. M. Merkow, & J. Breithaupt, Information security: Principles and practices. Upper Saddle River, NJ:Prentice Hall, 2005

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Secure Software Design and Enterprise Computing	**CO 1**	Differentiate between various software vulnerabilities.
		CO 2	Software process vulnerabilities for an organization.
		CO 3	Monitor resources consumption in a software.
		CO 4	Interrelate security and software development process.

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2MCS2-16: Wireless Sensor Networks

Course Code	
Course Name	Wireless Sensor Networks
Credits	3
Pre-Requisites	Wireless Communication

Total Number of Lectures: 40

COURSE OBJECTIVE
• Architect sensor networks for various application setups.
• Devise appropriate data dissemination protocols and model links cost.
• Understanding of the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers.
• Evaluate the performance of sensor networks and identify bottlenecks.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Wireless Sensor Networks: Course Information, Introduction to Wireless Sensor Networks: Motivations, Applications, Performance metrics, History and Design factors. **Network Architecture:** Traditional layered stack, Cross-layer designs, Sensor Network Architecture. **Hardware Platforms:** Motes, Hardware parameters.	8
Unit 2: Medium Access Control Protocol design: Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled. **Introduction to Markov Chain:** Discrete time Markov Chain definition, properties, classification and analysis. **MAC Protocol Analysis:** Asynchronous duty-cycled. X-MAC Analysis (Markov Chain).	8
Unit 3: Security: Possible attacks, countermeasures, SPINS, Static and dynamic key distribution.	6
Unit 4: Routing protocols: Introduction, MANET protocols. **Routing protocols for WSN**: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast. **Opportunistic Routing Analysis**: Analysis of opportunistic routing (Markov Chain) Advanced topics in wireless sensor networks.	10
Unit 5: Advanced Topics: Localization in WSNs, Quality of Service, Data Aggregation	8

References:

1. W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks –Theory and Practice", Wiley 2010

2. KazemSohraby, Daniel Minoli and TaiebZnati, "wireless sensor networks -Technology, Protocols, and Applications", Wiley Interscience 2007

3. Takahiro Hara, Vladimir I. Zadorozhny, and Erik Buchmann, "Wireless Sensor Network Technologies for the Information Explosion Era", springer 2010

4. B. Krishnamachari, Networking Wireless Sensors, 1st Edition, Cambridge University Press, 2005

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Wireless Sensor Networks	**CO 1**	Describe and explain radio standards and communication protocols for wireless sensor networks.
		CO 2	Explain the function of the node architecture and use of sensors for various applications.
		CO 3	Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.

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2MCS1-06: High Performance Computing Lab

The laboratory will require GPU based systems with OpenMP installed. The students be encouraged to configure the system. In the beginning, the students may undertake following preliminary exercises as below:

1. Analysis of Parallel Algorithms
2. Implementation using OpenMP
3. GPU kernel implementation for the given application.
4. Performance analysis using GPU memories.
5. Kernel reduction.
6. Profiling an application.

Once, the students are well versed with the environment, the exercises on the following may be taken. Datasets may be downloaded and used for the exercises:

1. Multiplication of Huge Matrices using CUDA
2. Sorting large data sets
3. Text Processing
4. Video Processing/ Image Analysis using CUDA

The list can be modified at the institute level depending upon the specialization of the faculty and availability of datasets.

2MCS1-07: Data Analytics Lab

The Laboratory shall have a multicore server running Hadoop or any similar platform. Alternatively, desktop with Multicore processor and 64/128GB RAM can be used to install Hadoop. R shall also be available in the Laboratory

Exercises:

A. Hadoop
   1. Install, configure and run Hadoop and HDFS
   2. Implement word count / frequency programs using MapReduce
   3. Implement an MR program that processes a weather or similar dataset. Dataset needs to be found and used.

B. R/ Python
   4. Implement Linear and logistic Regression
   5. Implement SVM / Decision tree classification techniques
   6. Implement clustering techniques
   7. Visualize data using any plotting framework
   8. Implement an application that stores big data in Hbase / MongoDB / Pig using Hadoop / R.

3MCS2-01: Business Intelligence

Course Code	
Course Name	Business Intelligence
Credits	3
Pre-Requisites	

Total Number of Lectures: 40

COURSE OBJECTIVE
• To develop problem solving abilities using Mathematics
• To apply algorithmic strategies while solving problems
• To develop time and space efficient algorithms
• To study algorithmic examples in distributed, concurrent and parallel environments

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Concepts with Mathematical treatment: Introduction to data, Information and knowledge, Decision Support System, Theory of Operational data and informational data, Introduction to Business Intelligence, Defining BI Cycle, BI Environment and Architecture, Identify BI opportunities, Benefits of BI. Role of Mathematical model in BI, Factors Responsible for successful BI Project, Obstacle to Business Intelligence in an Organization.	8
Unit 2: Decision Making Concepts: Concepts of Decision Making, Techniques of Decision Support System (DSS), Development of Decision Support System (DSS), Applications of DSS, Role of Business Intelligence in DSS.	6
Unit 3: Data-Warehouse: Definition, Characteristics, Types, Data Warehousing Framework, DwH 3 Tier Architecture, Alternative Architectures, Data Warehousing Integration, Data Warehousing – Development Approaches, Real-time Data Warehousing, Distributed data warehouse.	6
Unit 4: Data Pre-processing and Data Visualization: Data Analytics life cycle, Discovery, Data preparation, Pre-processing requirements, data cleaning, data integration, data reduction, data transformation, Data discretization and concept hierarchy generation, Model Planning, Model building, Communicating Results & Findings, Operationalizing, Introduction to OLAP. Real-world Applications,) Data Visualization: Definition, New Direction in Data Visualization, GIS, GIS vs GPS.	8
Unit 5: Designing and managing BI systems: Determining infrastructure requirements, planning for scalability and availability, managing and maintenance of BI systems, managing BI operations for business continuity.	6
Unit 6: BI and Data Mining Applications: Data analytics, business analytics, ERP and Business Intelligence, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications, BI Applications in Fraud Detection, BI Applications in Retail Industry.	6

Text Books:
1. R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support,10th Edition. Pearson/Prentice Hall, 2015. ISBN-13: 978-0-13-305090-5, ISBN-10: 0-13-305090.

References:

1. Introduction to business Intelligence and data warehousing, IBM, PHI.
2. Data mining concepts and techniques, Jawai Han, Michelline Kamber, Jiran Pie, Morgan Kaufmann Publishers 3rd edition.
3. Building the data Warehouse, William H Inmon, Wiley Publication 4th edition.
4. Data Mining for Business Intelligence, WILEY
5. Soumendra Mohanty, Analytics in Practice,Tata McGraw Hill Education, 2011, ISBN-13 978 0 07 0707061
6. Ken W. Collier,Agile Analytics: Avalue driven Approach to Business Intelligence and Data Warehousing, Pearson Education,2012, ISBN-13 978 8131786826
7. Donald Miner, MapReduce Design Pattern, O'Reilly, 2012, ISBN 978 9350239810
8. EMC Educational Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley ISBN-13 978 1118876138
9. BoS Content: Books, Course Notes, Digital contents, Blogs developed by the BoS for bridging the gaps in the syllabus, problem solving approaches and advances in the

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Business Intelligence	**CO 1**	To write case studies in Business Analytic and Intelligence using mathematical models.
		CO 2	To present a survey on applications for Business Analytic and Intelligence.
		CO 3	To write problem solutions for multi-core or distributed, concurrent/Parallel environments

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3MCS2-02: Block-chain Technologies

Course Code	
Course Name	Block-chain Technologies
Credits	3
Pre-Requisites	

Total Number of Lectures: 40

COURSE OBJECTIVE
• The objective of this course is to provide conceptual understanding of how block chain technology can be used to innovate and improve business processes.
• The course covers the technological underpinning of block Chain operations in both theoretical and practical implementation of solutions using block Chain technology.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Crypto currency to Block chain, Permissioned Model of Block chain.	5
Unit 2: Overview of Security aspects of Block chain Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency.	5
Unit 3: Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.	10
Unit 4: Understanding Block chain for Enterprises Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Execute contracts, State machine replication, Overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak- ease BFT Algorithm, BFT over Asynchronous systems.	9
Unit 5: Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Block chain.	5
Unit 6: Block chain application development: Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, writing smart contract using Hyperledger Fabric, writing smart contract using Ethereum, Overview of Ripple and Corda.	6

References:

Text Books:

1. Melanie Swan, "Block Chain: Blueprint for a New Economy", O'Reilly, 2015
2. Josh Thompsons, "Block Chain: The Block Chain for Beginners- Guide to Block chain Technology and Leveraging Block Chain Programming"
3. Daniel Drescher, "Block Chain Basics", Apress; 1stedition, 2017
4. Anshul Kaushik, "Block Chain and Crypto Currencies", Khanna Publishing House, Delhi.
5. Imran Bashir, "Mastering Block Chain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Packt Publishing
6. Ritesh Modi, "Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Block Chain", Packt Publishing
7. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer", Import, 2018.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Block-Chain Technologies	**CO 1**	Understand block chain technology.
		CO 2	Develop block chain-based solutions and write smart contract using Hyperledger Fabric and Ethereum frameworks.
		CO 3	Build and deploy block chain application for on premise and cloud-based architecture.
		CO 4	Integrate ideas from various domains and implement them using block chain technology in different perspectives.

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3MCS2-03: Social Network Analysis

Course Code	
Course Name	Social Network Analysis
Credits	3
Pre-Requisites	

Total Number of Lectures: 40

COURSE OBJECTIVE
• The course is an introduction to the concepts and methods of social network analysis.
• Students will learn to extract and manage data about network structure and dynamics, and to analyze, model and visualize such data.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Social Network: Analysis Steps in social network analysis: network definition, manipulation, calculation, visualization. Graph terminology. Social networks. Technological networks. Sampling and data characteristics.	6
Unit 2: Metrics Measures of Centrality: PageRank, Hubs and Authorities. Betweenness. Transitivity, Reciprocity. Structural balance. Homophily and assortativity.	5
Unit 3: Large-Scale Structure of Networks: Shortest-paths and the small-world effect. Degree distributions. Power laws and scale-free networks. Clustering coefficients. Basic graph algorithms: computing properties of nodes and dyads. Maximum flow.	5
Unit 4: Clustering Graph Partitioning: Spectral partitioning. Modularity and modularity maximization. Ego analysis Bi-partite networks Analysis of local networks. Structural holes theory. Measures of constraint. Bi-partite and affiliation networks. One-mode projections and analyses.	10
Unit 5: Exponential Random Graph Modelling Frameworks for Evaluating Results in Network Analysis: Autocorrelation, matching techniques, QAP regression, exponential random graphs, and p* models. Computational considerations. Lab: Applying ERGM analysis.	10
Unit 6: Network Evolution Actor models: Network dynamics vs behaviour dynamics. RSiena. Model creation and estimation.	4

References:

Text Books:

1. Newman, M.E.J. Networks: An Introduction. Oxford University Press. 2010.
2. Snijders, et al. Introduction to stochastic actor-based models for network dynamics. Social Networks, 2010.
3. Social Network Analysis for Startups Maksim Tsvetovat, Alexander Kouznetsov
4. Analyzing Social Networks [Borgatti, Stephen P, Everett, Martin G., Johnson, Jeffrey C.]

5. Models and Methods in Social Network Analysis (Structural Analysis in the Social Sciences) Peter J. Carrington

Course Outcome:

Course Code	Course Name	Course Outcome	Details
	Social Network Analysis	**CO 1**	Collect whole and personal network data and input it into social network analysis packages
		CO 2	Transform data for analysis using graph-based and statistics-based social network measures
		CO 3	Visualize network data using different methods and packages
		CO 4	Apply node and group level social network measures
		CO 5	Build and test network models at the nodal, dyadic and network levels
		CO 6	Choose among social network designs based on research goals
		CO 7	Apply social network theory to example data sets and to your own work

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