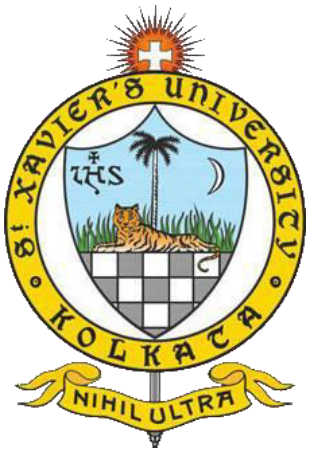

M. Sc. in Computer Science
with specialization in
Networking and Cyber Security/ Data Analytics

Faculty of Science

Department of Computer Science

St. Xavier's University, Kolkata

M.Sc. Computer Science with specializations in:

1. Networking and Cyber Security
2. Data Analytics

Total Marks: 2400

Total Credit: 96

Semester wise details

Semester - I							
Number of Papers : 5							
Course Code	**Course Title**	**Course Type**	**Credits in each course**				
			Theory	**Practical**	**Tutorial**	**Credits**	**Total Marks**
MCSR110C	Advanced Analysis of Algorithms	Core	3	2	0	5	[20(CIA) + 40(T)] + 40(P)
MCSR120C	Distributed System	Core	3	2	0	5	[20(CIA) + 40(T)] + 40(P)
MCSR130T	Automata and Compiler Design	Core	4	0	0	4	20(CIA) + 80(T)
MCSR140C	Statistical Analysis using Python	Core	2	3	0	5	[20(CIA) + 30(T)] + 50(P)
MCSR150C	Artificial Intelligence and Soft Computing	Core	3	2	0	5	[20(CIA) + 40(T)] + 40(P)
Total			**15**	**9**	**0**	**24**	**500**

Semester - II							
Number of Papers : 5							
Course Code	**Course Title**	**Course Type**	**Credits in each course**				
			Theory	**Practical**	**Tutorial**	**Credits**	**Total Marks**
MCSR210C	Cryptography and Cryptanalysis	Core	3	1	0	4	[20(CIA) + 60(T)] + 20(P)
MCSR220C	Machine Learning	Core	3	2	0	5	[20(CIA) + 40(T)] + 40(P)
MCSR230C	Embedded and Real Time Systems	Core	2	2	1	5	[20(CIA) + 40(T)] + 40(P)
MCSR240C	Advanced Software Engineering	Core	3	2	0	5	[20(CIA) + 40(T)] + 40(P)
MCSR250C	Operation Research and Research Methodology	Core	3	2	0	5	[20(CIA) + 40(T)] + 40(P)
Total			**14**	**9**	**1**	**24**	**500**

Semester - III							
Number of Papers : 5 + 2							
Course Code	**Course Title**	**Course Type**	**Credits in each course**				
			Theory	**Practical**	**Tutorial**	**Credits**	**Total Marks**
MCSR310C	Computer Vision	Core	3	2	0	5	[20(CIA) + 40(T)] + 40(P)
MCSR320C	Data Warehouse and Mining	Core	3	2	0	5	[20(CIA) + 40(T)] + 40(P)
MCSR330T	Mobile and wireless Computing	Core	2	0	0	2	20(CIA) + 80(T)
Specialization Bucket: 01 (Networking and Cyber Security)							
MCSR341T	Cloud Computing	Core	4	0	0	4	20(CIA) + 80(T)
MCSR351T	Network Security		4	0	0	4	20(CIA) + 80(T)
Specialization Bucket: 02 (Data Analytics)							
MCSR342T	Business Intelligence	Core	4	0	0	4	20(CIA) + 80(T)
MCSR352T	Deep Learning		4	0	0	4	20(CIA) + 80(T)
MCSR360P	Smart Analytics System Design Lab	Core	0	2	0	2	20(CIA) + 80(P)
MCSR370J	Project – Phase 1	Core	0	0	2	2	20(CIA) + 80(J)
Total			**14**	**9**	**1**	**24**	**700**

Semester - IV							
Number of Papers : 3 + 3							
Course Code	**Course Title**	**Course Type**	**Credits in each course**				
			Theory	**Practical**	**Tutorial**	**Credits**	**Total Marks**
Specialization Bucket: 01 (Networking and Cyber Security)							
MCSR411T	Cyber Law and Ethics	Core	4	0	0	4	20(CIA) + 80(T)
MCSR421T	Security for Cyber Physical system		4	0	0	4	20(CIA) + 80(T)
MCSR431T	IOT and Smart Systems		4	0	0	4	20(CIA) + 80(T)
Specialization Bucket: 02 (Data Analytics)							
MCSR412T	Bio-informatics	Core	4	0	0	4	20(CIA) + 80(T)
MCSR422T	NLP and Text Analytics		4	0	0	4	20(CIA) + 80(T)
MCSR432T	Social Network Analytics		4	0	0	4	20(CIA) + 80(T)
MCSR440J	Term Paper	Core	0	0	2	2	20(CIA) + 80(P)
MCSR450J	Project – Phase II **	Core	0	0	8	8	40(CIA) + 160(P)
MCSR460V	General Viva-Voce	Core	0	0	2	2	100(P)
Total			**12**	**0**	**12**	**24**	**700**

***CIA: Continuous Internal Assessment, T: Theory, P: Practical and C: Combine**

*** Publication of at least ONE research paper in UGC recognized Journal is Desirable.*

Programme Outcomes

PO 1: Ability to apply mathematical, statistical and programming knowledge to tackle challenging problems.

PO 2: Gaining keen understanding of the hardware aspect of a system and its relationship with software.

PO 3: Conducting rigorous experimentation to analyze and interpret data.

PO 4: Building models which are technically robust and in-line with best computing practices.

PO 5: Understanding the internal details of a computational process for identification and correction of erroneous scenarios.

PO 6: Analyzing the proposed solution to a problem based upon well-defined computational parameters.

PO 7: Learning to document research findings in a scientific and systematic manner.

PO 8: Recognizing learning as a lifelong process and the need to being self-taught.

MCSR110C
Advanced Analysis of Algorithm

Credit: 5
Semester: I
Nature of the Course: Core Course

Course Outcomes (CO):
CO1: To understand the concepts of time and space complexity, worst case, average case and best case complexities and the big-O notation
CO2: To apply design principles and concepts to algorithm design.
CO3: To understand the mathematical foundation in analysis of algorithms.
CO4: To understand different algorithmic design strategies.
CO5: To analyze the efficiency of algorithms using time and space complexity theory

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction	Definition of algorithms, Characteristics of algorithms, Types of algorithms: Recursive, Non-recursive	10	CO1
II	Performance evaluation of Algorithms	Efficiency of an algorithm in terms of space and time, Asymptotic notation (Big-O, Big-Omega, Big-Theta, Small-O, Small-Omega), Best Case, Worst Case, Average Case, Recurrence Relations, Master's Theorem for Recursive Algorithms	12	CO1, CO2
III	Divide and Conquer Paradigm	Binary Search, Quick Sort, Merge Sort, Strassen's Algorithm for Matrix Multiplication	16	CO2, CO3
IV	Greedy Paradigm	Knapsack problem, Huffman Coding, Job Sequencing problem, Activity Selection Problem	8	CO1, CO2, CO3
V	Dynamic Programming Paradigm	Fibonacci Sequence, Longest Common Sub Sequence, Matrix Chain Multiplication, Subset Sum Problem	5	CO4, CO5
VI	Graph Algorithms	Traversal algorithms: BFS, DFS, Minimal Spanning Tree algorithms: Prim's, Kruskal's, Single Source Shortest Path Algorithms: Dijkstra's, Floyd Warshall, Topological Sort	8	CO5, CO6
VII	Classification of problems	Concept of P, NP, NP-hard, NP-complete, SAT Problem, Cook's Theorem	5	CO6

Practical:
The following topics are to be covered:
1. Implementation of Divide and Conquer problems such as Binary Search, Quick Sort, Merge Sort
2. Implementation of Greedy problems such as Knapsack and Huffman Coding

3. Implementation of DP problems such as Matrix Chain Multiplication and Subset Sum Problem
4. Implementation of Graph algorithms such as BFS, DFS, Prim's Kruskal's among others

Suggested Books:

1. T. H. Cormen et al –Introduction to Algorithms, PHI
2. E. Horowitz, S. Sahani – Fundamentals of Computer Algorithms – Galgotia 3. Bratley et al – Fundamentals of Algorithms-PHI

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	H		M	
CO2	M	M	H	M		H		M
CO3	M	H	M	M	M		H	M
CO4	H	M	M	M				M
CO5	M	M	M	M		M		M
AVG	2.4	2.4	2.4	2.2	1	1	1	1.6

***H means High relevance (3), M means Medium relevance (2), L means Low relevance (1)*

MCSR120C
Distributed System

Credit: 5
Semester: I
Nature of the Course: Core Course

Course Outcomes (CO):

1. Gain ability to employ modern computer languages, environments, and platforms in creating innovative career paths.
2. Professional Skills: The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity.
3. Problem-Solving Skills: The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.
4. Achieve an ability to implement, test and maintain computer-based system that fulfils the desired needs.
5. Successful Career and Entrepreneurship: The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction	Definition of Distributed System, Difference with Centralized System, Advantages and Disadvantages	10	CO1
II	Communication in Distributed Systems	Review of the OSI Model, Client Server Model, Remote Procedure Call	12	CO1, CO2
III	Synchronization in Distributed Systems	Clocks, Centralized, Distributed and Token Ring Algorithms for Mutual Exclusion, Bully and Ring Algorithms for Election, Deadlocks in Distributed Systems and comparison with Centralized Systems	16	CO2, CO3
IV	Processes and Processors in Distributed Systems	Threads, System Models, Processor Allocation, Scheduling, Fault Tolerance	15	CO1, CO2, CO3
V	Distributed File Systems	Design, Implementation and Trends in Distributed File Systems	8	CO4, CO5
VI	Distributed Shared Memory	Definition of shared memory, Consistency Models, Page-based distributed shared memory	8	CO5

Practical:
Special reference may be given to Operating System as a concurrent program in UNIX environments

Suggested Books:

1. Tanenbum,A.S., Distributed Operating Systems ,Pearson Education. 2. Singhal,Shivaratri, Advanced Concepts in Operating Systems, TMH. 3. P.K.Sinha, Distributed Operating Systems, PHI
2. D.M. Dhamdhere, Operating Systems – A Concept Based Approach, Second Edition, TMGH, 2006, New Delhi

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M		H		
CO2	M	H	M	H	M		H	M
CO3	M		H	H		M		M
CO4	M	H	M		M			M
CO5	M	M	H		H		M	M
AVG	2	2	2.4	1.6	1.4	1	1	1.6

***H means High relevance, M means Medium relevance, L means Low relevance*

MCSR130T
Automata and Compiler Design

Credit: 4
Semester: I
Nature of the Course: Core Course

Course Outcomes (CO):

1. Providing a strong foundation on theoretical aspects of Computer Science by strengthening mathematical and scientific competencies.
2. Acquiring expertise in the latest technological tools for development and experimentation.
3. Building cutting-edge solutions to challenging societal problems that meets industry standards.
4. Forming research bent of mind in areas of interest.
5. Encouraging students to take up higher education, research, and entrepreneurship.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction to Automata Theory	Definition of automaton, Alphabet, Language, Finite Automaton (DFA, NFA, Epsilon-NFA, Mealy Machine, Moore Machine), Construction of Finite Automata from language, Conversion of NFA to DFA, Minimization of DFA, Construction of Mealy and Moore Machines from language, Inter-conversion of Mealy and Moore Machines	10	CO1
II	Families of Formal Languages	Regular expressions, Examples of regular expressions, Identities of regular expressions, Testing whether a language is regular or not, Examples of regular languages	12	CO1, CO2
III	Grammar	Definition, Chomsky's Classification of Grammars, Grammar as a generator of languages, Elimination of parameters from CFG (null productions, unit productions, useless symbols), Representation of CFG (CNF, GNF)	10	CO2, CO3
IV	Phases of Compilation	Definition of compiler, Different phases of compilation, Symbol Table, Ambiguous grammars and making them unambiguous, Elimination of left recursion, Elimination of non-determinism	7	CO1, CO2, CO3
V	Parsers	Recursive descent, LL(1), LR(0), SLR(1), LALR(1), CLR(1)	15	CO4, CO5

Suggested Books:

1. Introduction to Automata Theory, Languages, and Computation by John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, 3rd Edition, Pearson.
2. Theory of Computer Science (Automata, Languages & Computation) by K L P Misra & N Chandrasekharan, 3rd Edition, PHI.
3. Switching and Finite Automata Theory by ZviKohavi, Niraj.K.Jha, 3rd Edition, TMH.
4. Formal Language and Automata, P. Linz, Narosa

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	M		M		
CO2	M	H	H	M	H		H	M
CO3	M	M	M	M		H		
CO4	M	H	H	M				M
CO5	M	M	M	M	M		M	M
AVG	2	2.6	2.6	5	1	1	1	1.2

***H means High relevance, M means Medium relevance, L means Low relevance*

MCSR140C
Statistical Analysis using Python

Credit: 5
Semester: I
Nature of the Course: Core Course

Course Outcomes (CO):

1. Students will understand the basic statistical and Mathematical tools applicable for data analysis.
2. Apply probability distributions to a variety of problems in various diversified fields. Develop a framework for the null hypothesis, level of significance, one-tailed and two-tailed tests of significance and their importance in testing of hypothesis.
3. This would create a practical environment in the lab to facilitate the students to learn models/algorithm etc. which are crucial in understanding Data Science/Machine Learning in future/subsequent semesters. This framework will include different Python libraries like Pandas, Numpy, Matplotlib, Seaborn, Scipy, Statistics.
4. Students should be thoroughly conversant in using Python based framework (like Jupyter, IDLE, Anaconda etc.) in the computer systems. They should understand how to load different data sets from different sources, Data wrangling, preparation, missing data analysis. Students will use different types of Statistical, Mathematical, data visualization tools while doing EDA.
5. In the practical classes, students will be given hands on exposure to the computer systems installed with Python framework. In each class, they will run the code simultaneously in the systems as demonstrated in the faculty's system followed by the assignments.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Exploratory Data Analysis	Introduction to IRIS dataset, Scatter plots (2-D, 3-D), Pair Plots, Histogram, Probability Density Function (PDF), Univariate Analysis, Cumulative Distribution Function (CDF), Mean, Variance, Standard Deviation, Median, Percentiles, Quartiles, Inter quartile range, Median Absolute Deviation, Box plot with whiskers, Violin plots, Contour plot for multivariate analysis	12	CO1, CO2
II	Applied Probability and Statistics	CDF of Gaussian Distribution, Symmetric distribution, Skewness, Kurtosis, Standard Normal Variable, Standardization, Kernel Density Estimation (KDE), Sampling Distribution, Central Limit Theorem, Q-Q Plot, Chebyshev's Inequality, Discrete and Continuous Uniform Distributions, Log Normal Distributions, Power law distributions, Box Cox transforms, Co-variance, Pearson Correlation Coefficient, Spearman Rank Correlation Coefficient,	41	CO3

		Confidence Interval, Hypothesis Testing, Resampling and permutation testing, K-S Test		
III	Dimensionality Reduction	Data matrix, Feature Normalization, Mean and Co-variance of Data Matrix, Column Standardization, Demonstration on MNIST Dataset of Handwritten digits, Principal Component Analysis (PCA) as a tool for dimensionality reduction and visualization, t-SNE as a tool for dimensionality reduction and visualization	12	CO4, CO5

Practical:
All statistical techniques are to be covered on popularly available data sets or synthetic data sets created using random values.

Suggested Books:
1. Practical Statistics for Data Scientists, 2e: 50+ Essential Concepts Using R and Python by Peter Bruce, Andrew Bruce, Peter Gedeck, O'Reilly
2. Head First Statistics: A Brain-Friendly Guide by Dawn Griffiths, O'Reilly 3. Think Stats: Exploratory Data Analysis, Second Edition by Allen Downey, O'Reilly

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	H		L		M
CO2	M	H	M		L		H	
CO3	H	M	M	M		M		M
CO4	M	M	M		M		M	
CO5	M	M	H	L		H		M
AVG	2.2	2.2	2.4	1.2	0.6	1.2	1	1.2

***H means High relevance, M means Medium relevance, L means Low relevance*

MCSR150C
Artificial Intelligence and Soft Computing

Credit: 5
Semester: I
Nature of the Course: Core Course

Course Outcomes (CO):

1. Comprehend the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context.
2. Formulate a problem as State-Space Exploration Framework or an Inferencing Framework of Artificial Intelligence.
3. Use the strategies of AI-Heuristics to find acceptable solutions avoiding brute-force techniques.
4. Understand and explain the basic concept of soft computing and hard computing and apply them in designing solution to engineering problem.
5. Identify and formulate learning rules for each of the architectures and learn several neural network paradigms and its applications to solving engineering and other problems.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction	Definition, Importance of AI in fields of education, healthcare, medicine, environment, Advantages and disadvantages of AI, AI as a superset of Machine Learning, Data Science and Deep Learning	10	CO1
II	State Space search	State Space Graphs, Implicit and explicit graphs, Production Systems, formulating the state-space; Uninformed search: breadth first search, depth first search; Uniform cost algorithm; Informed search: use of heuristics, A* algorithm, Admissibility of A*; Analysis and comparison of search algorithms	12	CO2, CO3
III	Adversarial Search	Two agent games, AND/OR graphs, Min-max procedure, and game trees, Alpha – Beta pruning procedure, learning evaluation functions	10	CO3
IV	Constrained Satisfaction Search	Introduction to Constrained Satisfaction search (CSP), Applications, Algorithms to CSPs, Symbolic constraints and propagation.	15	CO4
V	Fuzzy Systems	Introduction to fuzzy logic, Fuzz set v/s Crisp set, Fuzzy relation, Fuzzy set operations, Entropy of fuzzy set, Composition of fuzzy set, Properties of fuzzy set, Defuzzification	12	CO4, CO5
VI	Soft Computing and Neural Networks	Definition, Comparison with traditional computing, Characteristics, Applications, History of neural network and Deep Learning,	10	CO5

		Working of biological neurons, Growth of biological neural networks, Perceptron, Multi-layer Perceptron (MLP), Training an MLP, Backpropagation, Activation functions, Vanishing gradient problem, Bias-Variance tradeoff		

Practical:

The following topics are to be covered:

1. Logic programming using PROLOG or LISP
2. Implementing Neural Networks from scratch using Python

Suggested Books:

1. Elaine Rich and Kevin Knight: Artificial Intelligence, TMH
2. Dan W. Patterson: Introduction to Artificial Intelligence and Expert Systems, PHI
3. S. Russel and P. Norvig, "Artificial Intelligence, A modern Approach"

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	M		H		M
CO2					L		M	
CO3	H	M	L	H		M		M
CO4	L	L	M		H		H	
CO5	M	M		L		L		M
AVG	1.6	1.4	1.2	1.2	0.8	1.2	1	1.2

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MCSR210C
Cryptography and Cryptanalysis

Credit: 4
Semester: II
Nature of the Course: Core Course

Course Outcomes (CO):

1. To understand the basic concepts in cryptography
2. To apply the deployment of different encryption techniques to secure messages in transit across data networks
3. To discuss various techniques used to assure Integrity and Authentication
4. To analyze diverse security measures and issues in practice
5. Do research in the emerging areas of cryptography and network security

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction	Dimensions of Security, Classification of attacks, Definition of Cryptography, Advantages of Cryptography, Applications of Cryptography in the modern-era, Real-world case studies on use of cryptography, Cryptography v/s Network Security	8	CO1
II	Mathematics behind Symmetric Key Cryptography	Set of Integers, Binary Operations on Integers, Modular Arithmetic, Matrices, Determinants, Linear Congruence, Group, Ring, Field	7	CO1, CO2
III	Symmetric Key Ciphers	Shift Cipher, Ceaser Cipher, Substitution Ciphers (Mono-alphabetic ciphers, Poly-alphabetic ciphers), Transposition Ciphers (Keyless, Keyed), Hill Cipher, Play Fair Cipher, Stream Ciphers, Block Ciphers, DES, AES	15	CO3
IV	Mathematics behind Asymmetric Key Ciphers	Prime Numbers, Euler's Phi Function, Fermat's Little Theorem, Euler's Theorem, Factorization, Chinese Remainder Theorem	7	CO3, CO4
V	Asymmetric Key Ciphers	Keys, Trapdoor One-way function, RSA Cryptosystem	15	CO4, CO5
VI	Integrity, Authentication, Key Management	Hash Functions, Digital Signature, Passwords, Kerberos	7	CO5

Practical:

The following topics are to be covered:

1. Encryption/Decryption using Caesar Cipher, Substitution Cipher and Hill Cipher
2. Implementation of DES algorithm
3. Implementation of RSA algorithm

4. Implementation of Diffie-Hellman Key Exchange mechanism
5. Implementation of One Time Password mechanism

Suggested Books:

1. Computer Security: Art and Science, M. Bishop, Pearson Education.
2. Information Security: Principles and Practice, M. Stamp, John Wiley & Sons.
3. Cryptography and Network Security, William Stallings, Eastern Economy Edition, PHI.
4. Cryptography and Network Security, Behrouz A Forouzan, McGraw Hill Education.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	H		M		M
CO2	M	H	M		H		L	M
CO3	H	M	M	M		M		M
CO4	M	M	M			L	L	M
CO5	M	M	H	L	M		H	M
AVG	2.2	2.6	2.4	1.2	1	1	1	2

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MCSR220C
Machine Learning

Credit: 5
Semester: II
Nature of the Course: Core Course

Course Outcomes (CO):

1. Understand the basic concepts of machine learning to Explain or Illustrate and Identify problems where students can Apply the concept appropriately to Solve them.
2. Understand the fundamental concepts of regression analysis so that they can propose models for predicting values based on exemplary data and analyze their performances.
3. Explain or illustrate the fundamental strategies of unsupervised machine learning paradigm to solve clustering problems and analyze their performances.
4. Explain or illustrate the concepts of Mining Frequent Patterns, Associations and Data Streams and Apply them to solve the relevant problems and analyze their performances.
5. Develop ideas to Propose solutions to the problems of supervised.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction to Classification and Regression: KNN	How classification works, Data Matrix Notation, Classification v/s Regression (examples), KNN intuition, Failure cases of KNN, Distance measures: Euclidean, Manhattan, Minkowski, Hamming, Cosine Distance and Cosine Similarity, Measuring effectiveness of KNN, Test/Evaluation time and Space Complexity, KNN Limitations, Decision surface for KNN as K changes, Overfitting and Underfitting, Cross validation, KNN for regression	12	CO1
II	Classification Algorithms	Naive Baye's, Logistic Regression, Linear Regression, SVMs, Decision Trees, Ensemble Models	12	CO4, CO5
III	Tuning of Classification algorithms	Imbalanced v/s Balanced datasets, Multi-class classification, Train and Test set differences, Impact of outliers, Local outlier factor, Reachability distance, Impact of scale and column standardization, Feature importance and Forward Feature Selection, Handling categorical and numerical features, Handling missing values, Curse of Dimensionality, Bias-Variance trade-off	15	CO3, CO4
IV	Performance measurement of Models	Accuracy, Confusion Matrix, ROC Curve, AUC, Log-loss, Coefficient of determination, Median Absolute Deviation, Distribution of errors	10	CO2, CO3

V	Unsupervised Learning	Discriminative Models: Clustering k-means (clustering), PCA (dimensionality reduction), Generative Models Latent variable models: expectation-maximization for learning latent variable models	15	CO5

Practical:

The case studies listed under are to be implemented**.**

Case Study – Marketing Attribution using Mathematical Models, Quora Question Pair Similarity Problem, Personalized Cancer Diagnosis, Stack Overflow Tag Predictor, Microsoft Malware Detection

Suggested Books:

1. Machine Learning by Tom M. Mitchell, TMH
2. Machine Learning by Saikat Dutt et al, Pearson
3. Introduction to Machine Learning with Python: A Guide for Data Scientists by Andreas Muller, O'Reilly
4. Hands-On Machine Learning with Scikit-Learn, Keras and Tensor Flow: Concepts, Tools and Techniques to Build

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M						M
CO2		H	H	L		L		
CO3	L	M	M		L	M		
CO4	M	H				L	M	M
CO5	M	M			L		M	M
AVG	1.4	2.4	1	0.2	0.4	0.8	0.8	1.2

***H means High relevance, M means Medium relevance, L means Low relevance*

MCSR230C
Embedded and Real Time Systems

Credit: 5 Semester: II
Nature of the Course: Core Course

Course Outcomes (CO):

CO1: Understand the concept of embedded and real time system.
CO2: Learn the architecture and programming of ARM Microcontroller.
CO3: Explore the basic concepts of real time system design.
CO4: Learn the electronic circuit design through Verilog
CO5: Apply and analyze embedded and real time systems for better application development.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction to Embedded and Real time Systems	Definition, example and classification; basic components; applications; challenges	10	CO1,CO2
II	Embedded Serial Communication	Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor Network, UART	10	CO1, CO2
III	ARM architecture and Cortex – M series	Introduction to the ARM Cortex M4 and its targeted applications, ARM Cortex M4 architecture address space, on- chip peripherals (analog and digital) Register sets, addressing modes and instruction set basics; Stacks and Subroutines; Peripherals – The Timer Unit – Pulse Width Modulation Unit	10	CO2,CO5
IV	Real Time Systems	Structure of a Real Time System Estimating program runtimes–Task Assignment and Scheduling–Fault Tolerance Techniques–Reliability,Evaluation–Clock Synchronization.	15	CO3
V	Embedded system programming	Embedded C /applications for ARM-v7, using ARM-GCCtool-chain, Emulation of ARM-v7 (e.g. using QEMU), and Linux porting on ARM-v7 (emulation) board CASE STUDY: 1) Medical monitoring systems, 2) Process control system (temp, pressure) 3) Soft real time: Automated vending machines, 4) Communication: Wireless (sensor) networks	15	CO2,CO3
VI	System design using Verilog	Introduction to Hardware Description Languages(HDL)and HDL based design, Hardware Modelling with Verilog HDL – Logic System, Data Types and Operators For modelling in Verilog HDL - Behavioral Descriptions in Verilog HDL – HDL Based Synthesis – Synthesis of Finite State Machines– structural modeling – compilation	15	CO4

		and simulation of Verilog code –Testbench - Realization of combinational and sequential circuits using Verilog – Registers – counters – sequential machine – serial adder – Multiplier-Divider – Design of simple microprocessor		

Practical:

Module V and Module VI are to be covered in LAB.

Suggested Readings:

1. Raj Kamal, Embedded Systems Architecture, Programming and Design, 3rdEd., McGraw Hill
2. Ray, Bhurchandi, Advanced Microprocessors and Peripherals, TMH
3. Mazidi,McKinlay,The8051MicrocontrollerandEmbeddedSystems,Pearson–PrenticeHall
4. Barry Brey, The Intel Microprocessors: TMH

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M						L
CO2	L	H	H	L		L		
CO3	L	M	M		L	M		
CO4	M	H				L	M	H
CO5	M	H			L		M	M
AVG	1.6	2.6	1	0.2	0.4	0.8	0.8	1.2

***H means High relevance, M means Medium relevance, L means Low relevance*

MCSR240C
Advanced Software Engineering

Credit: 5
Semester: II
Nature of the Course: Core Course

Course Outcomes (CO):

1. A general understanding of software engineering, process and software process models.
2. Interprets minimum requirements, types of requirements for the development of application.
3. Describes various system models for business processes and understanding the existing system.
4. Develops and maintains efficient reliable software solutions by creating a blueprint for further development.
5. Constructs software engineering testing and risk strategies and develops their appropriate applications. Develops critical thinking and evaluate assumptions and argument.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Software Engineering Fundamentals	Software Process, Software Life Cycle Standards, Software Requirements Analysis & Specification, Software Design.	8	CO1
II	Testing	Testing Fundamentals, System Testing, Integration Testing, Black Box Testing, White Box Testing, Testing Process, Software Maintenance	10	CO1, CO2
III	Project management	Process, software configuration process models, requirements change management process, Process management process	12	CO2, CO3
IV	Effort Estimation	Function Points, COCOMO, Project scheduling and staffing, Risk Management	10	CO3
V	Software metrics and Reliability	Errors, Faults and Failures, Reliability as a Quality Attribute, Requirements Reliability Metrics, Textual Requirement Analysis, Design and Code Reliability Metrics, Testing Reliability Metrics,	15	CO4, CO5
VI	ISO Standard	ISO 9000: 2000: contains Quality management systems, fundamentals, and vocabulary, ISO 9001: 1994: This series of standards has Quality systems and a Quality assurance model. This model helps in design, development, production, installation, and service	12	CO5

Practical:

The following points are to be covered:

1. Project based on PERT/CPM
2. SRS to Deployment of model

3. Applying Software Engineering tools for Cloud-based problems

Suggested Books:

1. Software Engineering: A Practitioner's Approach by R.S. Pressman, McGraw-Hill
2. Fundamentals of Software Engineering by R. Mall, PHI
3. Software Engineering by I. Sommerville, Addison Wesle
4. Software Engineering for Students by D. Bell, Addison-Wesley

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H		H		L	M
CO2	M	H	M	L		L		
CO3	H	M	M		M			M
CO4	M	M	M	L		M	L	
CO5	M	M	H	H		M	H	M
AVG	2.2	2.2	2.4	1	1	1	1	1.2

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MCSR250C
Operation Research and Research Methodology

Credit: 5
Semester: I
Nature of the Course: Core Course

Course Outcomes (CO):

1. Providing a strong foundation on theoretical aspects of Computer Science by strengthening mathematical and scientific competencies.
2. Acquiring expertise in the latest technological tools for development and experimentation.
3. Building cutting-edge solutions to challenging societal problems that meets industry standards.
4. Forming research bent of mind in areas of interest.
5. Encouraging students to take up higher education, research, and entrepreneurship.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction of Operation Research	Definition, Concept, Meaning, Phases, Scope, Advantages, Disadvantages, Mathematical Modeling of Real Life Problems	8	CO1
II	Pre-requisite to Linear Programming	Introduction to Linear algebra, Solution of a system of Linear Equations, Linear independence and dependence of vectors, Concept of Basis, Basic Feasible solution, Convex sets, Extreme points, Hyperplanes and Halfspaces, Convex cones, Polyhedral sets and cones	10	CO1, CO2
III	Linear Programming Problem	Linear Programming Problem Formulation, solution by Graphical Method, Theory of Simplex Method, Simplex Algorithm, Two phase Method, Charnes-M Method, Degeneracy, Theory of Duality, Dual-simplex method	12	CO3
IV	Introduction of Research Methodology	Overview of research; Types of Research approaches: fundamental, pure or theoretical research, applied research, evaluation research, survey research; Sources of research problem; Criteria/Characteristics of a good research problem; Scope and objectives of research problem; Formulation of a research problem, identifying variables, constructing hypotheses, errors in selecting a research problem. 2. Research design: Objectives, Strategies, Guidelines for design of experiments. Selecting a study design. 3.	15	CO4

		Literature survey – Reviewing the literature, Survey using Web of Science, Survey using Scopus, Literature survey writing up, importance of Review of literature.		
V	Data and Statistics	Sources of Data, Documentary Sources, Field Sources, Methods of Data Collection. Data analysis – Definition, Types of analysis, Terminology in data analysis, Data Preparation, Classification, and Visualization of data, assessing data and reporting results; Descriptive statistics: Measure of Central Tendency, Measure of Dispersion, Measure of Relation. Modelling skills – Concept, Different modelling approaches 5. Experimental skills, Safety in laboratory. Testing of Hypothesis: Meaning of Hypothesis, Need for Hypothesis, Types of Hypothesis, Sources of Hypothesis, Functions of Hypothesis, Character of Good Hypothesis, Statistical Testing of Hypothesis, One Sample Test, Two Independent Sample Tests	12	CO4, CO5
VI	Research Ethics	Ethics in Research, Ethics and Research Process, Importance of Ethics in Research Plagiarism: Introduction of Plagiarism, Dimension of Plagiarism, Detect Plagiarism, Strategies to Minimize Plagiarism.	10	CO5

Practical:

1. LPP exercises are to be carried out.
2. Technical writing – LaTeX, Microsoft Word

Suggested Books:

1. Operations Research by Kanti Swarup, P.K. Gupta, Man Mohan, Sultan Chand & Sons
2. Schaum's Outline of Operations Research, Richard Bronson and Govindasami Naadimuthu, McGraw-Hill Education
3. Operations Research: An Introduction, Hamady.A. Taha, TMH
4. Research Methodology: Methods And Techniques by C.R. Kothari and Gaurav Garg, New Age International Publishers
5. Research Methodology: Methods And Techniques by R K Jain, Vayu Education of India
6. Research Methodology: Concepts And Cases by Deepak Chawla and Neena Sondhi, Vikas Publishing House

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	L		H		M
CO2	M	H	M		M	L		
CO3	H	M	M	L			M	M
CO4	M	M	M		M		H	M
CO5	M	M	H	H	L	L		M
AVG	2.2	2.2	2.4	1	1	1	1	1.6

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MCSR310C
Computer Vision

Credit: 5
Semester: III
Nature of the Course: Core Course

Course Outcomes (CO):

1. Providing a strong foundation on theoretical aspects of Computer Science by strengthening mathematical and scientific competencies.
2. Acquiring expertise in the latest technological tools for development and experimentation.
3. Building cutting-edge solutions to challenging societal problems that meets industry standards.
4. Forming research bent of mind in areas of interest.
5. Encouraging students to take up higher education, research, and entrepreneurship.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Digital Image formation and low-level processing	Overview and State-of-the-art techniques, Fundamentals of image formation, Transformation: Orthogonal, Euclidean, Affine, Projective etc., Image Enhancement, Restoration, Histogram processing	15	CO1
II	Feature Extraction	Edges-Canny, Line detectors (Hough Transform), Harris-Corners and Hessian Affine, Orientation Histogram, Feature Selection: Principal Component Analysis (PCA)	12	CO1, CO2
III	Image Segmentation	Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation, Object Detection	15	CO2, CO3
IV	Object Detection and Classification	Feature Based, Deep Learning Based	12	CO1, CO2, CO3
V	Case Study	Human Iris Location, hole detection, Generalized Hough Transform (GHT), Spatial matched filtering, object location, health, agriculture and biometric application	15	CO4, CO5

Practical:

OpenCV: Installation and setup, Basic image operations, mathematical operations on images, bitwise operations, image annotations, QR code detection, using mouse, video I/O

Suggested Books:

1. "Computer Vision: A Modern Approach", by Forsyth and Ponce
2. "Multiple View Geometry in Computer Vision", by Hartley and Zisserman
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

4. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
5. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
6. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
7. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
8. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	H				M
CO2	M	H	M		L		M	M
CO3	H	M	M	M		H		M
CO4	M	M	M		M		M	M
CO5	M	M	H	L		M	L	M
AVG	2.2	2.2	2.4	1.2	0.6	1	1	2

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MCSR320C
Data Warehouse and Mining

Credit: 5
Semester: III
Nature of the Course: Core Course

Course Outcomes (CO):

CO1: Learn data warehouse principles, data mining concepts and working.
CO2: Analyze and describe complex data types with respect to spatial and web mining.
CO3: Identify appropriate data mining algorithms to solve real world problems.
CO4: Design data warehouse with dimensional modelling and apply OLAP operations.
CO5: Benefit the user experiences towards research and innovation integration.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction to Data Warehouse	Concept of Data warehousing, Need for data warehousing, Basic elements of data warehousing, Trends in data warehousing	15	CO1, CO2
II	Architecture and planning of Data Warehouse projects	Project planning and management, Collecting the requirements, Architectural components, Infrastructure and metadata	15	CO4
III	Data Warehouse design and representation	Principles of dimensional modelling, Dimensional modelling advanced topics, data extraction, transformation and loading, data quality, Matching information to classes of users, OLAP in data warehouse, Data warehousing and the web, Introductory Concept of Hadoop and MapReduce, Physical design process, data warehouse deployment, growth and maintenance	15	CO4
IV	Introduction to Data Mining	Basics of data mining, related concepts, Data mining techniques, Data Mining Algorithms: Classification, Clustering, Association rules, Knowledge Discovery: KDD Process, Data mining primitives, Query language, Designing GUI based on a data mining query language, Architectures of data mining systems, Data generalization and summarization-based characterization, Analytical characterization: analysis of attribute relevance, Mining class comparisons: Discriminating between different classes, Mining descriptive statistical measures in large databases	15	CO3, CO5

V	Trends in data mining	Web Content Mining, Web Structure Mining, Web Usage mining, Spatial mining, Temporal mining, Applications, Systems products and research prototypes, Additional themes in data mining, Trends in data mining	15	CO2, CO5

Practical:

Installation of WEKA Tool; Creating new Ariff File; Pre-Processes Techniques on Data Set; Pre-process a given dataset based on Handling Missing Values; Generate Association Rules using the Apriori Algorithm; Generating association rules using fp growth algorithm; Build a Decision Tree by using J48 algorithm; Naïve bayes classification on a given data set; Applying k-means clustering on a given data set; Calculating Information gains measures; OLAP Cube and its different operations; Case Study: Create Student. Ariff file to suggest better college using Decision tree; Case Study: Create Placement. Ariff file to identify the students who are eligible for placements using KNN

Suggested Books:

1. Data Mining Concepts and Techniques by Jiawei Han and Micheline Kamber, Morgan Kaufmann Publishers.
2. Data Warehousing, Data Mining and OLAP by Berson, Tata McGraw Hill.
3. Introduction to Data Mining by Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	L			H	H		
CO2	M	H	M	L			H	
CO3	L	M	L	M	L	L		
CO4	M	H	M	H		L	M	H
CO5	M	H			M		M	H
AVG	2	2.4	1	1.2	1.2	1	1.4	1.2

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MCSR330T
Mobile and wireless Computing

Credit: 2
Semester: I
Nature of the Course: Core Course

Course Outcomes (CO):

1. Analyze the working of modern communication technologies.
2. Demonstrate the various routing algorithms for both infrastructure based and ad hoc networks.
3. Develop mobility and bandwidth management in cellular network
4. Design and build an energy efficient and secure mobile computing environment using heterogeneous wireless technologies
5. Identify the technical issues related to recent mobile computing environment

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Wireless Networks	Introduction, Wireless Technology Satellite Communications: Parameters & configurations, Capacity Allocation Cellular Wireless Networks: Principles, Evolution Wireless LANs: Technology, IEEE 802.11 Wireless LAN Standard, Radio based Wireless LANs, Components, Configuration, Performance, Wi-Fi, Wimax	7	CO1
II	Introduction to Mobile Computing	Emerging Technologies, GSM, SMS, GPRS, EDGE, 3G, 4G	4	CO2
III	Multiple Access Techniques	Frequency Division Multiple access, Time Division Multiple Access, Aloha, Slotted Aloha, CSMA	7	CO3
IV	Mobile Network And Transport Layer	Mobile IP- Goals and requirements, Entities, IP packet delivery, Agent Discovery, Registration, Tunneling and Encapsulation, Optimizations, Reverse Tunneling, Classical TCP- Indirect TCP, snooping TCP, Mobile TCP, Transmission/time out freezing and advancements	5	CO4, CO5
V	Mobile Ad hoc Network	Introduction, Routing protocols- Routing, Dynamic source routing, Destination sequence distance vector, Overview ad-hoc routing protocols, Application- RFID, Bluetooth, Zigbee, NFC	7	CO5

Suggested Books:

1. Wireless Communications and Networks William Stallings Pearson Education
2. Mobile Communications Jochen Schiller Pearson
3. Wireless Communications Principles and Practice Theodore S. Rappaport.
4. Wireless Networking Kumar, Manjunath & Kuri, Morgan Kaufmann Publishers
5. Mobile Computing, Asoke K Telukder, Roopa R Yavagal, TMH

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	H		H	L	M
CO2	M	H	M		H			M
CO3	H	M	M	M		L	L	M
CO4	M	M	M		L			M
CO5	M	M	H		M	M	H	M
AVG	2.2	2.2	2.4	1	1.2	1.2	1	2

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MCSR341T
Cloud Computing

Credit: 4
Semester: III
Nature of the Course: Specialization Course (Networking and Cyber Security)

Course Outcomes (CO)

1. Articulate the business model concepts, architecture and infrastructure of cloud computing, including cloud service models and deployment models.
2. Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms.
3. Explore some important cloud computing driven commercial systems such as Google Apps, Microsoft Azure and Amazon Web Services and other businesses cloud applications.
4. Analyze the core issues of cloud computing such as security, privacy, interoperability, and its impact on cloud application.
5. Learn the Concept of Cloud Infrastructure Model.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction to Cloud Computing	Cloud issues and challenges – Properties – Characteristics – Service models, Deployment models.	10	CO1
II	Cloud resources	Network and API – Virtual and Physical computational resources – Data-storage. Virtualization concepts – Types of Virtualization- Introduction to Various Hypervisors – High Availability (HA)/Disaster Recovery (DR) using Virtualization, Moving VMs .	12	CO1, CO2
III	Service models	Infrastructure as a Service (IaaS) – Resource Virtualization: Server, Storage, Network – Case studies. Platform as a Service (PaaS) – Cloud platform & Management: Computation, Storage – Case studies. Software as a Service (SaaS) – Web services – Web 2.0 – Web OS – Case studies – Anything as a service (XaaS).	15	CO3
IV	Cloud Programming and Software Environments	Parallel and Distributed Programming paradigms – Programming on Amazon AWS and Microsoft Azure – Programming support of Google App Engine – Emerging Cloud software Environment.	10	CO3, CO4
V	Cloud Access	Authentication, authorization and accounting – Cloud Provenance and meta-data – Cloud Reliability and fault-tolerance – Cloud Security, privacy, policy and compliance-	12	CO5

		Cloud federation, interoperability and standards.		

Suggested Books:

1. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley,2011
2. Enterprise Cloud Computing – Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010
3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India,2010

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H			H		M
CO2	M	H	M	L	M		M	
CO3	H	M	M	L		M		M
CO4	M	M	M		M		L	
CO5	M	M	H	H	L	L	L	M
AVG	2.2	2.2	2.4	1	1	1.2	1	1.2

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MCSR342T
Business Intelligence

Credit: 4
Semester: III
Nature of the Course: Specialization Course (Data Analytics)

Course Outcomes (CO):

1. Understand the concept of Business Intelligence (BI) and its importance in decision-making processes. Gain knowledge of the fundamental components and technologies used in BI systems, such as data warehouses, data marts, ETL (Extract, Transform, and Load) processes, and data visualization tools.
2. Develop skills in data modeling and design for BI systems, including dimensional modeling, star and snowflake schemas, and data integration techniques. Learn various data analysis and reporting techniques used in BI, including OLAP (Online Analytical Processing), data mining, and statistical analysis.
3. Gain proficiency in using BI tools and software, such as Tableau, Power BI, or QlikView, to extract insights and generate reports from data. Understand the process of data extraction, cleansing, and transformation for BI purposes, including data quality and data governance considerations.
4. Explore the role of data visualization in presenting insights effectively and creating intuitive dashboards and reports.
5. Understand the concepts of data-driven decision-making and how BI supports strategic planning, performance monitoring, and business optimization.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction to Business Intelligence	Describe BI, its components & architecture, previewing the future of BI Crafting a better experience for all business users, End User Assumptions, Setting up Data for BI, The Functional Area of BI Tools, Query Tools and Reporting, OLAP and Advanced Analytics	10	CO1
II	Elements of Business Intelligence Solutions	Reports & ad hoc queries; Analyse OLAP data; Dashboards & Scorecards development, Metadata Models, Consume BI through portals, web applications, Desktop applications	12	CO2, CO3
III	Building the BI Project	Project Resources; Project Tasks, Risk Management and Mitigation, Cost-justifying BI solutions and measuring success, Collecting User Requirements, Requirements-Gathering Techniques	12	CO3
IV	Reporting authoring	Drill up, drill- down, drill-through capabilities. Run or schedule report, different output forms – PDF, excel, csv, xml etc	10	CO4, CO5
V	BI Deployment,	OLAP Implementations. Expanding BI	15	CO5

	Administration & Security	Authentication Authorization, Access Permissions, Groups and Roles, Single-sign on Server Administration, Manage Status & Monitoring, Audit, Mail server & Portal integration		

Suggested Books:

Business Intelligence (IBM ICE Publication)

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	L		M	L	M
CO2	M	H	M		H			M
CO3	H	M	M	L		L	H	
CO4	M	M	M		M			M
CO5	M	M	H	M		M	M	M
AVG	2.2	2.2	2.4	1	1	1	1.2	1.6

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MCSR351T
Network Security

Credit: 4
Semester: III
Nature of the Course: Specialization Course (Networking and Cyber Security)

Course Outcomes (CO):

1. Identify the security issues in the network and resolve it.
2. Analyse the vulnerabilities in any computing system and hence be able to design a security solution.
3. Evaluate security mechanisms using rigorous approaches by key ciphers and Hash functions.
4. Demonstrate various network security applications, IPSec, Firewall, IDS, Web Security, Email Security and Malicious software etc.,
5. Understand key management and distribution schemes and design User Authentication

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction	Security Attacks (Interruption, Interception, Modification and Fabrication), Security Services(Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms, A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking, ARP attacks, route table modification, UDP hijacking, and man-in-the-middle attacks.	10	CO1
II	Classical Encryption Techniques	Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, key distribution Approaches of Message Authentication, Secure Hash Functions and HMAC	12	CO1, CO2
III	Asymmetric Cryptosystem	Public key cryptography principles, public key cryptography algorithms, digital signatures, digital Certificates, Certificate Authority and key management Kerberos, X.509 Directory Authentication Service.	15	CO2, CO3
IV	Email privacy	Pretty Good Privacy (PGP) and S/MIME.IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management.	10	CO1, CO2, CO3
V	Parsers	Basic concepts of SNMP, SNMPv1 Community facility and SNMPv3. Intruders, Viruses and related	12	CO4, CO5

		threats. Firewall Design principles, Trusted Systems. Intrusion Detection Systems.		

Suggested Books:

1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.
2. Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, JoeGrand, David Ahmad, Hal Flynn Ido Dubrawsky, Steve W.Manzuik and Ryan Permeh, Wiley Dreamtech
3. Network Security and Cryptography: Bernard Menezes, CENGAGE Learning
4. Network Security - Private Communication in a Public World by CharlienKaufman, Radia Perlman and Mike Speciner, Pearson/PHI
5. Cryptography and network Security, Third edition, Stallings, PHI/Pearson
6. Principles of Information Security, Whitman, Cengage Learning

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	M	M	M	H	M
CO2	M	H	M			L		
CO3	H	M	M	M	L	H		M
CO4	M	M	M					
CO5	M	M	H	M	M		H	M
AVG	2.2	2.2	2.4	1.2	1	1.2	1.2	1.2

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MCSR352T
Deep Learning

Credit: 4
Semester: III
Nature of the Course: Specialization Course (Data Analytics)

Course Outcomes (CO):

1. Apply the concept of neural networks, including layers and activation functions to observe deep learning models.
2. Explain the concept of backpropagation to optimize neural network weights.
3. Analyze different dimensionality reduction techniques for real world dataset.
4. Evaluate different deep learning models for optimized solution of Natural Language Processing related problems.
5. Design deep learning solutions for complex real-world Problems using different deep learning tools.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Deep Learning Concepts	Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.	10	CO1
II	Convolutional Neural Network	About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data.	15	CO2, CO3
III	Transfer Learning	Transfer Learning. Transfer Learning with Image Data. RCNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO. Knowledge Distillation: Principles, Algorithms, Applications.	12	CO3

IV	RNN	RNN Introduction, Bidirectional RNNs (BRNN). Long Short-Term Memory (LSTM). Bi-directional LSTM. Sequence-to- Sequence Models (Seq2Seq). Gated recurrent unit GRU.	10	CO4, CO5
V	Deep Reinforcement & Unsupervised Learning	About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Autoencoders for Classification. Denoising Autoencoders. Sparse Autoencoders	12	CO5

Suggested Books:

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, JojoMoolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, SantanuPattanayak, Apress,2017

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M			H	M	L	H
CO2	M	H	H	H				
CO3		M	M	M	L	M	H	M
CO4	M		M	L				
CO5	M	M	H		L	M	L	M
AVG	1.6	1.8	2	1.2	1	1.2	1	1.4

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MCSR360P
Smart Analytics System Design

Credit: 2
Semester: III
Nature of the Course: Core Course
Course Outcomes (CO)

1. Recall the basic components of smart analytics system design and development.
2. Analyse smart analytics system requirements, product design and architecture.
3. Design and implement a smart analytics system based on the software engineering design principles.
4. Develop a smart analytics system solution/artefact for a real-world problem from the domains of health care, agriculture, finance, transportation of logistics, and sustainability and present their work.
5. To learn open source platform for system development.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
1	Introduction: General system design and principles, Smart analytics systems System requirements and Feasibility Study	Smart analytic systems and types, Importance of system design in smart analytics, Problem statement and feasibility – stakeholders' expectations, System requirements modelling for a real world problem related to the domains of health care, agriculture, finance, transportation of logistics, and sustainability.	7	CO1
2	System architecture, Design solution definition	System design concepts, requirements and architectural design, System design requirements and data modelling, Component level design: Design of various system components, User interface design: Design of user interface and behavioural design, User interface design: Design of user interface and behavioural design, System design solution definition and development of solution	7	CO1, CO2
3	System development - safety and Security Features, System testing	System design solution development and documentation – contd., System safety and security features, System design verification and testing	5	CO3
4	Project demonstration and presentation	Project demonstration and presentation, Smart analytics system design development and documentation - iteration	4	CO3, CO4

	- draft1, System design iteration			
5	Project Demo, Final Project design and development documentation and reports	Final smart analytics project demonstration and presentation, Submission of final documents and reports	7	CO5

- Problems for the domains of the following areas should be emphasis: Health Care, Agriculture, Finance, Transportation of Logistics, and Sustainability.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M				M		H
CO2	L	H	H	H	M	M	M	
CO3		L	M			L		M
CO4	M		L	L	M		H	
CO5	M	M	H	M	L	L	L	L
AVG	1.4	1.6	1.8	1	1	1.2	1.2	1.4

***H means High relevance, M means Medium relevance, L means Low relevance*

MCSR370J
Project – Phase 1

Credit: 2
Semester: III
Nature of the Course: Core Course

Course Outcomes (CO):

1. Demonstrate a sound technical knowledge of their selected mini project topic.
2. Undertake problem identification, formulation, and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Communicate with engineers and the community at large.
5. Demonstrate the knowledge, skills, and attitudes of a professional engineer.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	M		H			H
CO2	H	M	M	H		M		H
CO3	H	H	H		M		H	M
CO4	M	M	H	M		H		H
CO5	M	H	M	M	H		M	M
AVG	2.6	2.6	2.4	1.4	1.8	1	1	2.6

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MCSR411T
Security for Business Infrastructure, Cyber Law and Ethics

Credit: 4
Semester: IV
Nature of the Course: Specialization Course (Data Analytics)

Course Outcomes (CO):

1. Undertake legal research at a high level of complexity in relation to issues of cyber security and cyber conflict.
2. Effectively structure and articulate written legal arguments.
3. Deploy advanced skills in statutory interpretation, including in particular in relation to the Privacy Act, the Security of Critical Infrastructure Act and the Commonwealth Criminal Code, to resolve complex legal problems arising in relation to cyber security and cyber conflict law.
4. Analyse a complex factual scenario and identify the relevant legal issues arising in relation to issues of cyber security and cyber conflict.
5. Identify and evaluate relevant ethical and moral issues in legal situations arising in relation to cyber security and cyber conflict.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Security Awareness, Compliance, Assessments, and Risk	Social Engineering, Phishing, Security Awareness, Security Assessment and Audit, What is GRC? NIST Framework Overview, PCI-DSS Framework Overview, Challenges of Compliance versus Security	10	CO1
II	Hybrid Guard: Elevating Enterprise Security in the Hybrid Cloud Era	Hybrid Cloud Security Enterprise Shift to Hybrid Cloud, Workload Micro-Segmentation, Defense in Depth through Micro-Segmentation, Cloud Access Security Brokers, Advanced Hybrid Cloud Security Architecture, Security of Isolated Servers	12	CO1, CO2
III	Navigating the Landscape of Cybersecurity	Introduction to Cyber security Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues, and challenges of cyber security	10	CO2, CO3
IV	Exploring Cybercrime and Cyber Law	Cyber-crime and Cyber law Classification of cyber-crimes, Common cyber-crimes- cyber-crime targeting computers and mobiles, cyber-crime against women and children, financial frauds, social engineering attacks,	15	CO1, CO2, CO3

		malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber-crimes, Remedial and mitigation measures, Legal perspective of cyber-crime, IT Act 2000 and its amendments, Cyber-crime and offences, Organizations dealing with Cyber-crime and Cyber security in India, Case studies		
V	Blockchain Sentry	Blockchain, Anonymity, and Critical Infrastructure Protection: Blockchain, Cyber Attribution Onion Routing and Tor Chaum Binding Algorithm	12	CO4, CO5

Suggested Books

1. Cyber Security and IT Infrastructure Protection, John R. Vacca, Syngress Publisher, O'Reilley
2. Cyber Law and Ethics: Regulation of the Connected World, Eric P. Robinson and Mark Grabowski, Routledge; 1st edition

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H	L	H		M	M
CO2	M	H	M	L		M	M	
CO3	H	M	M			M		M
CO4	M	M	M				M	
CO5	M	M	H	H	H	L		M
AVG	2.2	2.2	2.4	1	1.2	1	1.2	1.2

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MCSR412T
Bio-informatics

Credit: 4
Semester: IV
Nature of the Course: Specialization Course (Data Analytics)

Course Outcomes (CO):

1. Acquire the knowledge of Bioinformatics technologies with the related concept of DNA, RNA and their implications.
2. Develop idea in Molecular Biology.
3. Understand the concept and techniques of different types of Data Organization and Sequence Databases with different types of Analysis Tools for Sequence Data Banks.
4. Acquire the knowledge of the DNA Sequence Analysis.
5. Analyze the performance of different types of Probabilistic models used in Computational Biology.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Basic Biology	What is life? The unity and the diversity of living things. Prokaryotes and Eukaryotes, Yeast and People, Evolutionary time and relatedness, Living parts: Tissues, cells, compartments and organelles, Central dogma of molecular biology, Concept of DNA, RNA, Protein and metabolic pathway. What is Bioinformatics? Recent challenges in Bioinformatics	7	CO1
II	Biological databases	Their needs and challenges. Example of different biological databases – sequence, structure, function, micro-array, pathway, etc	12	CO1, CO2
III	Sequence Analysis	Theory and Tools: Pairwise alignment – Different local and global search alignment, Heuristic searches (like BLAST) applicable to search against database, Multiple alignment algorithms, Whole genome comparison	15	CO2, CO3
IV	Walk through the genome	Prediction of regulatory motifs, Operon, Gene, splices site, etc	10	CO3
V	Markov models	Hidden Markov models – The evaluation, decoding and estimation problem and the algorithms. Application in sequence analysis	7	CO3, CO4
VI	Molecular phylogeny	Maximum Parsimony, distance Matrix and maximum likelihood methods. Concepts of adaptive evolution	5	CO4, CO5

VII	Application of graph theory in Biology	Biochemical Pathway, Protein-protein interaction network, Regulatory network and their analysis	7	CO5

Suggested Books:

1. Bioinformatics: David Mount
2. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic acids, R. Durbin, S.R. Eddy, A. Krogh and G. Mitchison.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H					L	L	
CO2		L	M	L				
CO3	L	M		M	M			
CO4	M					M	M	
CO5		H		L		H		L
AVG	1.2	1.2	0.4	0.8	0.4	1.2	0.6	0.2

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MCSR421T
Security for Cyber-Physical Systems

Credit: 4
Semester: IV
Nature of the Course: Specialization Course (Data Analytics)

Course Outcomes (CO):

1. Know various modeling formalisms for CPS.
2. Identify safety specifications and critical properties.
3. Understand CPS security and safety aspects.
4. Understand abstraction in system designs.
5. Realize the basics of CPS implementation.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction	Cyber-Physical System (CPS), Key Features of CPS, Application Domains of CPS, Basic principles of design and validation of CPS, Challenges in CPS	15	CO1
II	CPS Platform components	CPS HW platforms, Processors, Sensors and Actuators, CPS Network -Wireless, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks, Synchronous Model and Asynchronous Model	15	CO1, CO2
III	Synchronous and Asynchronous Model	Reactive Components, Components Properties, Components Composing, Synchronous Designs and Circuits, Asynchronous Processes and operations, Design Primitives in Asynchronous Process, Coordination Protocols in Asynchronous Process, Leader Election, Reliable Transmission. Security of Cyber-Physical Systems: Introduction to CPS Securities, Basic Techniques in CPS Securities, Cyber Security Requirements, Attack Model and Countermeasures, advanced Techniques in CPS Securities	15	CO3
IV	CPS Application	Health care and Medical Cyber-Physical Systems, Smart grid and Energy Cyber-Physical Systems, WSN based Cyber-Physical Systems, Smart Cities	15	CO4, CO5

Suggested Books:

1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2011.
2. R. Alur, "Principles of Cyber-Physical Systems," MIT Press, 2015.
3. Raj Rajkumar, Dionisio de Niz and Mark Klein, "Cyber-Physical Systems", Addison-Wesley, 2017
4. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press, 2015
5. Fei Hu, "Cyber-Physical Systems", CRC Press 2013

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M		M	M	M	M	M	M
CO2	H	L	H	H	H		H	
CO3	M		M	M	L	M	M	L
CO4	M	L	M	M	M		M	M
CO5	M	H	M	M	M	L	M	
AVG	2.2	1	2.2	2.2	2	1	2.2	1

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MCSR422T
NLP and Text Analytics

Credit: 4
Semester: IV
Nature of the Course: Specialization Course (Data Analytics)

Course Outcomes (CO):

1. Apply the principles and Process of Human Languages such as English and other Indian Languages using computers.
2. Realize semantics and pragmatics of English language for text processing.
3. Check a current method for statistical approaches to machine translation.
4. Perform POS tagging for a given natural language and select a suitable language modelling technique based on the structure of the language.
5. Demonstrate the state-of-the-art algorithms and techniques for text-based processing of natural language with respect to morphology.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	NLP	Word Embeddings,POS tagging, Entity tagging, Topic Categorization, Opinion analysis	13	CO1
II	Deep Learning Models for NLP	Attention models, transformers, Recurrent networks, LSTM,	12	CO2
III	Formal Language and Grammar	Grammars and Parsing,	13	CO3
IV	NLU	Information Extraction (relationship, event extraction), Summarization, Entity resolution, wikification, Trending phrases, terminology discovery, Semantic Role Labeling, Textual Entailment	11	CO4
V	Recommender Systems	Collaborative filtering, Model based, content based, SVD, Sentiment Analysis, Ranking,	10	CO5

Suggested books:

1. Speech and Language Processing (3rd Edition) DanielJurafsky and James Martin, 2019. [SLP]
2. Recommender Systems Charu C. Aggarwal, Springer, 2016. [RS]
3. Social Media Mining Zafarni, Abbasi and Liu, Cambridge University Press, 2014. [SMM]

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	H		H	L	H	M
CO2	M	H	M	M				
CO3	H	M	M			H	L	M
CO4	M	M	M	L				M
CO5	M	M	H	H	M	M	L	M
AVG	2.2	2.2	2.4	1.2	1	1.2	1	1.6

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MCSR431T
IOT and Smart Systems

Credit: 4
Semester: IV
Nature of the Course: Specialization Course (Data Analytics)

Course Outcomes (CO):

1. Understand and differentiate the fundamental concepts of Internet of Things and the Internet.
2. Demonstrate the concepts of wireless sensor network, Analyze, and Identify appropriate.
3. Analyze and compare the basic protocols used in different OSI layer of wireless sensor network and IoT.
4. Describe IoT architecture and Machine to machine communication.
5. Design basic IoT applications and solve different real-life problems in different domains based upon the concept of IoT and sensor network.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Introduction to IoT	Brief History and evolution of IoT, Definition of IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT. Communication models and APIs	10	CO1
II	IoT & Machine to Machine	Machine to Machine, Difference between IoT and M2M, Software define Network, SDN and NFV for IoTs.	12	CO2, CO3
III	Challenges in IoT	IoT Services Platform: Functions and Requirements, Design challenges, Development challenges, Internet of Things Security and Privacy, Other challenges	15	CO3
IV	Developing Smart Applications	Developing IoTs Introduction to Python and IoT tools, developing applications through IoT tools, Developing sensor based application through IoT platform	12	CO4, CO5
V	Specific applications of IoT	IOT for Home automation, Smart Cities, Environment monitoring, IOT for financial inclusion, Logistics monitoring, IOT for rural empowerment, Industry applications, Health monitoring, Other IoT applications	10	CO5

Suggested Books:

1. Machine Learning and IoT for Intelligent Systems and Smart Applications, Madhumathy P, M Kumar, R. Umamaheswari, CRC Press
2. IoT Fundamentals: Networking Technologies Protocols And Use Cases For The Internet Of Things, Hanes David, Salgueiro Gonzalo, Grossetete Patrick, Barton Rob, Henry Jerome, Pearson Education; First Edition

3. IoT for Beginners: Explore IoT Architecture, Working Principles, IoT Devices, and Various Real IoT Projects, Vibha Soni, BPB Publications

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	L		M		L	M
CO2	M	H	M	H				
CO3	L	M	M		M	H	L	M
CO4	M	M	M	L				
CO5	L	M	H	M	L	H	H	M
AVG	1.6	2.2	2	1.2	1	1.2	1	1.2

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MCSR432T
Social Network Analytics

Credit: 4
Semester: IV
Nature of the Course: Specialization Course (Data Analytics)

Course Outcomes (CO):

1. Work on the internals components of the social network.
2. Model and visualize the social network.
3. Mine the behaviour of the users in the social network.
4. Predict the possible next outcome of the social network.
5. Apply social network in real time applications.

Course Content:

Module No.	Module Name	Chapter Topic	Lecture No.	CO
I	Social Network Analysis	Preliminaries and definitions, Erdos Number Project, Centrality measures, Balance and Homophily	10	CO1
II	Random graph models	Random graphs and alternative models, Models of network growth, Navigation in social Networks, Cohesive subgroups, Multidimensional Scaling, Structural equivalence, roles, and positions.	12	CO2, CO3
III	Network topology and diffusion	Network topology and diffusion, Contagion in Networks, Complex contagion, Percolation, and information, Navigation in Networks Revisited	15	CO3
IV	Small world experiments	Small world experiments, small world models, origins of small world, Heavy tails, Small Diameter, Clustering of connectivity, The ErdosRenyi Model, Clustering Models	12	CO4, CO5
V	Network structure	Important vertices and page rank algorithm, towards rational dynamics in networks, basics of game theory, Coloring and consensus, biased voting, network formation games, network structure and equilibrium, behavioral experiments, Spatial and agent-based models	10	CO5

Suggested Books:

1. S. Wasserman and K. Faust. “Social Network Analysis: Methods and Applications”, Cambridge University Press.
2. D. Easley and J. Kleinberg, “Networks, Crowds and Markets: Reasoning about a highly connected world”, Cambridge University Press, 1st edition,2010

3. Maarten van Steen. “Graph Theory and Complex Networks. An Introduction”, 2010.2)RezaZafarani, Mohammed Ali Abbasi, Huan Liu. “Social Media Mining: An Introduction”. Cambridge University Press 2014.
4. Maksim Tsvetovat and Alexander Kouznetsov. “Social Network Analysis for Startups”. O’Reilly Media, 2011.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	L		L		H	M
CO2	L	H	M	M			L	
CO3	M	M			M	H		M
CO4	H	M	M	M			M	M
CO5	H	L	H	L	L	L		M
AVG	2.2	2	1.6	1	0.8	1	1.2	1.6

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MCSR440J
Term Paper

Credit: 2
Semester: IV
Nature of the Course: Core Course

Course Outcomes (CO):

1. Gain an understanding of advanced research methodologies in the field, including theory, interdisciplinary approaches.
2. Demonstrate through short written assignments and critical reviews the ability to synthesize and assess the arguments of scholarly articles and monographs at the level of professionals in the field.
3. Understand the privileges and obligations associated with a career as a professional.
4. Understand historical and recent trends in theory and method and be able to identify and explain major trends and issues in industry and research.
5. Learn to write a scholarly review.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	M	M			H		M
CO2	M				H			H
CO3	H	L	H	H			H	M
CO4	M	M	M		H			H
CO5	M	M	M	H		H	H	M
AVG	2	1.4	1.8	1.8	1.8	1.8	1.8	2.4

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MCSR450J
Project – Phase II

Credit: 8
Semester: IV
Nature of the Course: Core Course

Course Outcomes (CO):

1. Demonstrate a sound technical knowledge of their selected mini project topic.
2. Undertake problem identification, formulation, and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Communicate with Technocrats and the community at large.
5. Demonstrate the knowledge, skills, and attitudes of a professional technocrats.

CO-PO mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	M	H			H	H
CO2	H	M	M		H			H
CO3	H	H	H			H		M
CO4	M	M	H	H		H		H
CO5	M	H	M		H		H	M
AVG	2.6	2.6	2.4	1.8	1.8	1.8	1.8	2.6

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MCSR460V
General Viva-Voce

Credit: 2
Semester: IV
Nature of the Course: Core Course

Course Outcomes (CO):

1. Explore their field of knowledge, which includes a critical awareness of current problems and/or new insights at the forefront of that field.
2. Understand of techniques applicable to their own area of professional practice.
3. Demonstrate originality in the application of knowledge, together with a practical understanding of how established techniques professional enquiries are used to create and interpret knowledge in their discipline.
4. Evaluate current professional practice in Computer Science and Engineering, to evaluate methodologies and develop critiques of them and, where appropriate, to propose new forms of practice or knowledge.
5. Demonstrate self-direction and originality in tackling and solving problems, and act autonomously in planning and implementing tasks at a professional or equivalent level.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M				M	M		M
CO2		L		H				
CO3	L		H		H	H	M	M
CO4		M		M				
CO5	M				M		H	M
AVG	1	0.6	0.6	1	1.4	1	1	1.2

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CO PO Mapping

Course Code	Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
MCSR110C	Advanced Analysis of Algorithm	2.4	2.4	2.4	2.2	1	1	1	1.6
MCSR120C	Distributed System	2	2	2.4	1.6	1.4	1	1	1.6
MCSR130T	Automata and Compiler Design	2	2.6	2.6	5	1	1	1	1.2
MCSR140C	Statistical Analysis using Python	2.2	2.2	2.4	1.2	0.6	1.2	1	1.2
MCSR150C	Artificial Intelligence and Soft Computing	1.6	1.4	1.2	1.2	0.8	1.2	1	1.2
MCSR210C	Cryptography and Cryptanalysis	2.2	2.6	2.4	1.2	1	1	1	2
MCSR220C	Machine Learning	1.4	2.4	1	0.2	0.4	0.8	0.8	1.2
MCSR230C	Embedded and Real Time Systems	1.6	2.6	1	0.2	0.4	0.8	0.8	1.2
MCSR240C	Advanced Software Engineering	2.2	2.2	2.4	1	1	1	1	1.2
MCSR250C	Operation Research and Research Methodology	2.2	2.2	2.4	1	1	1	1	1.6
MCSR310C	Computer Vision	2.2	2.2	2.4	1.2	0.6	1	1	2
MCSR320C	Data Warehouse and Mining	2	2.4	1	1.2	1.2	1	1.4	1.2
MCSR330T	Mobile and wireless Computing	2.2	2.2	2.4	1	1.2	1.2	1	2
MCSR341T	Cloud Computing	2.2	2.2	2.4	1	1	1.2	1	1.2
MCSR342T	Business Intelligence	2.2	2.2	2.4	1	1	1	1.2	1.6
MCSR351T	Network Security	2.2	2.2	2.4	1.2	1	1.2	1.2	1.2
MCSR352T	Deep Learning	1.6	1.8	2	1.2	1	1.2	1	1.4
MCSR360P	Smart Analytics System Design	1.4	1.6	1.8	1	1	1.2	1.2	1.4
MCSR370J	Project-Phase I	2.6	2.6	2.4	1.4	1.8	1	1	2.6
MCSR411T	Security for Business Infrastructure, Cyber Law and Ethics	2.2	2.2	2.4	1	1.2	1	1.2	1.2
MCSR421T	Security for Cyber-Physical Systems	2.2	1	2.2	2.2	2	1	2.2	1
MCSR431T	IOT and Smart Systems	1.6	2.2	2	1.2	1	1.2	1	1.2
MCSR412T	Bio-informatics	1.2	1.2	0.4	0.8	0.4	1.2	0.6	0.2
MCSR422T	NLP and Text Analytics	2.2	2.2	2.4	1.2	1	1.2	1	1.6
MCSR432T	Social Network Analytics	2.2	2	1.6	1	0.8	1	1.2	1.6
MCSR440J	Term Paper	2	1.4	1.8	1.8	1.8	1.8	1.8	2.4
MCSR450J	Project-Phase II	2.6	2.6	2.4	1.8	1.8	1.8	1.8	2.6
MCSR460V	General Viva-Voce	1	0.6	0.6	1	1.4	1	1	1.2
Avg		1.99	2.05	1.97	1.32	1.06	1.11	1.12	1.49