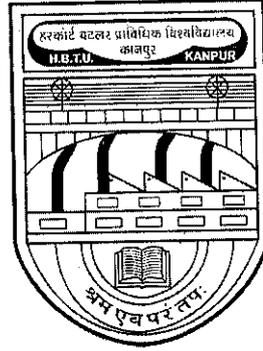


**Harcourt Butler Technical University, Kanpur**

**Department of Computer Science and Engineering**



**Syllabus**

**For**

**M. Tech. (Computer Science & Engineering)**

**(Effective from the Session: 2023-24)**

**Course structure and evaluation scheme for M. Tech Computer Science & Engineering**  
**(Effective from the Session: 2023-24)**

**SEMESTER –I**

S.No.	Course Type	Course Code	Course Title	Credits	Sessional Marks				ESM	Total Marks
					MSE	TA	Lab	Total		
1.	PCC	NCS-501	Advanced Algorithms	4(3-1-0)	30	20	-	50	50	100
2.	PCC	NCS-503	Professional Aspects of Software Engineering	4(3-1-0)	30	20	-	50	50	100
3.	PCC	NCS-505	Advanced Programming concepts using Python	4(3-0-2)	15	20	15	50	50	100
4.	PEC	NCS-	Departmental Elective I	4(3-1-0)	30	20	-	50	50	100
<b>Total Credits</b>					<b>16</b>					

**SEMESTER –II**

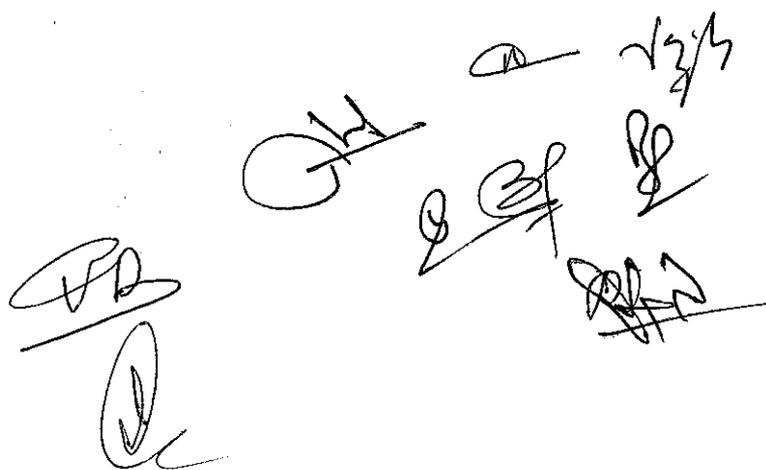
S.No.	Course Type	Course Code	Course Title	Credits	Sessional Marks				ESM	Total Marks
					MSE	TA	Lab	Total		
1.	PCC	NCS-502	Artificial Intelligence	4(3-0-2)	15	20	15	50	50	100
2.	PCC	NCS-504	Computer Networks & Security	4(3-1-0)	30	20	-	50	50	100
3.	PCC	NCS-506	Advanced Databases	4(3-1-0)	30	20	-	50	50	100
4.	PEC	NCS-	Departmental Elective II	4(3-1-0)	30	20	-	50	50	100
<b>Total Credits</b>					<b>16</b>					

### SEMESTER -III

S.No.	Course Type	Course Code	Course Title	Credits	Sessional Marks				ESM	Total Marks
					MSE	TA	Lab	Total		
1.	PEC	NCS-	Department Elective III	4(3-1-0)	30	20	-	50	50	100
2.	OEC	OCS-	Open Elective	3(3-0-0)	30	20	-	50	50	100
3.	Seminar	NCS-693	Seminar	1(0-0-2)	30	20	-	50	50	100
4.	Dissertation	NCS-695	Minor Dissertation	8(0-0-16)	30	20	-	50	50	100
<b>Total Credits</b>				<b>16</b>						

### SEMESTER -IV

S.No.	Course Type	Course Code	Course Title	Credits	Sessional Marks				ESM	Total Marks
					MSE	TA	Lab	Total		
1.	PCC	NCS-696	Dissertation	16(0-0-32)	30	20	-	50	50	100
<b>Total Credits</b>				<b>16</b>						















### List of Departmental Electives

	BASKET 1	BASKET 2	BASKET 3	BASKET 4	BASKET 5	BASKET 6
<b>Departmental Elective I</b>	Data Science NCS-511	Data Warehousing & Data Mining NCS-513	Multimedia Systems NCS-515	Wireless & Mobile Networks NCS-517	Modeling and Simulation NCS-519	Soft Computing NCS-521
<b>Departmental Elective II</b>	Cloud Computing NCS- 512	Software Requirements Engineering and Risk Management NCS- 514	Digital Image Processing NCS- 516	Storage Area Network NCS- 518	Real-Time Systems NCS- 520	Software Metrics & Quality Assurance NCS-522
<b>Departmental Elective III</b>	Machine Learning NCS-611	Software Project Planning & Management NCS-613	Digital Forensics NCS-615	High-Performance Networking NCS-617	Embedded Systems NCS-619	Bioinformatics NCS-621

**Open Elective: Machine Learning (OCS-)**

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# ADVANCED ALGORITHMS (NCS-501)

C (L T P)  
4 (3-1-0)

## Course Content

### Unit-1: Algorithm Fundamentals

Basic Concept, Analysis of Algorithm, Growth of Functions, Master's Theorem. Analysis of algorithms for classic problems in various domains.

### Unit-2: Randomized Algorithm

Introduction to Probabilistic Analysis and Randomized Algorithms, Quick sort randomized version, Searching in linear time.

### Unit-3: Advance Design and Analysis Techniques:

Dynamic Programming, Greedy Algorithms, Branch and bound, Back Tracking:  
Case studies.

### Unit-4: Computational Geometry

Introduction to Computational Geometry, NP-Completeness. Introduction to Approximation Algorithms.

### Unit-5: Parallel Algorithm

Performance Measures of Parallel Algorithms, Parallel Merging/Sorting Algorithms on CREW/EREW, and Parallel searching algorithms.

## Text and Reference Books

1. Coreman, Rivest, Lisserson, "Algorithm", PHI, 2009.
2. Basse, "Computer Algorithms: Introduction to Design & Analysis", Addison Wesley, 2002.
3. Horowitz, Sahani, and Rajasekaran "Fundamental of Computer Algorithms", Universities Press, 2019.

## Course Outcomes

1. Understand and apply mathematical preliminaries to the analysis and design of various types of algorithms.
2. Understand and apply the probabilistic analysis and randomized algorithms.
3. Apply various algorithmic strategies and paradigms to model engineering problems.
4. Understand NP completeness-related issues and approximation to np-complete problems.
5. Understand and apply the parallel algorithms in various research problems.

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# PROFESSIONAL ASPECTS OF SOFTWARE ENGINEERING (NCS-503)

C (L T P)  
4 (3-1-0)

## Course Content

### Unit-1

Introduction to Software Engineering: Defining the problem, identifying resources, identifying tools. Process models: The waterfall model, incremental process models, evolutionary process models, and the unified process. Agile Methodology- Scrum and XP, Fundamental concepts of Software Project Management.

### Unit-2

Object Oriented Software Engineering Object-oriented methodologies. Unified Modeling Language, Use Case Centric Development, Structural and Behavioral Modeling, User Interface design, Component and Deployment Diagrams, Design Principles, and Patterns.

### Unit-3

Component-Based Software Engineering: CBSE process, Domain engineering, Component-based development, Classifying and retrieving components, and economics of CBSE. Client/Server Software Engineering: Structure of client/server systems, Software engineering for Client/Server systems, Analysis modeling issues, Design for Client/Server systems, Testing issues

### Unit-4

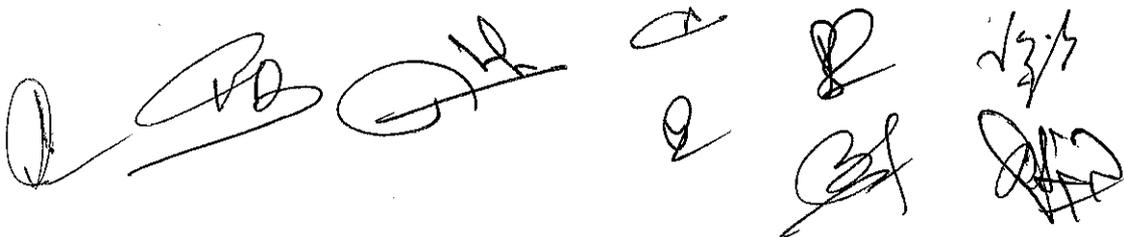
Web Engineering: Attributes Of web-based applications, the WebE process, and a framework for WebE. Formulating, and analyzing web-based systems, designing and testing for web-based applications, and Management issues.

### Unit-5

Software Quality: CASE tools, metrics, Standards, Certification, and Assessment. TQM, Bootstrap methodology, The SPICE project, ISO-IEC 15504, SEI-CMM, Six Sigma Concept for Software Quality. Computer-Aided Software Engineering: Building Blocks for CASE, taxonomy Of CASE tools, integrated CASE environments, Integration architecture, and CASE repository.

## Text and Reference Books

1. Sommerville, "Software Engineering, 9th ed.", Addison Wesley Professional, 2010, ISBN-13: 978-0137035151
2. Roger S. Pressman, Software Engineering a Practitioners Approach, McGraw-Hill, 2019.
3. K. K. Agrawal and Yogesh Singh, Software Engineering New Age Publishing, 2007.
4. Object-Oriented Software Engineering Practical software development using UML and Java by Timothy C. Lethbridge & Robert Langanieri McGraw-Hill Co, 2004.
5. Priestley, Object Oriented Design Using UML, McGraw Hill Co, 2005.

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## Course Outcomes

1. The ability to analyze and implement solutions to complex problems involving computer applications and networks
2. Ability to translate end-user requirements into system and software requirements, using e.g., UML, and structure the requirements in a Software Requirements Document (SRD).
3. Identify and apply appropriate software architectures and patterns to carry out the high-level design of a system and be able to critically compare alternative choices.
4. Will have experience and/or awareness of testing problems and will be able to develop a simple testing report
5. A solid understanding of the methods of modern software engineering

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- R
- EF
- PA

# ADVANCED PROGRAMMING CONCEPTS USING PYTHON (NCS-505)

C (L T P)  
4(3-0-2)

## Course Content

### Unit I

History, Features and Future of Python, Installation, Interactive Shell, Program Structure, Identifiers, Keywords, Escape Sequences, Data-Types, Variables, Assignments, Immutable Variables, Operators and Operands, Precedence of Operators, Type-Conversion Functions, Control Flow, Loops

### Unit 2

Defining, Calling and Types of Functions, Arguments and Return Values, Formal vs. Actual Arguments, Scope and Lifetime, Keyword Arguments, Default Arguments, Decorators, Iterators and Generators, Recursion. Importing Modules, Math and Random Module, Packages and Composition.

### Unit 3

**String Manipulations:** Basic functions of Strings, Subscript Operator, Indexing, Slicing and Immutable Strings.

**Data Structures:** Lists, Tuples, and Dictionaries, Basic List Operations, List Slicing, List Methods, Cloning Lists, Mutability, Searching and Sorting Lists, Tuples: Tuple Assignment, Tuple as Return Value, Dictionary Literals, Adding and Removing Items, Accessing and Replacing Values, Traversing Dictionaries, Sorting Dictionaries, Dictionary Operations, Sets Operations.

### Unit 4

Text Files-Writing and Reading Operations, Creating and Reading a Formatted File, Manipulating Files and Directories, Closing Files. Database Connectivity Operations: Create, Insert, Select, Delete, Drop, Update.

**Object Oriented Programming Concepts:** Classes, Objects, Attributes and Methods, Access Specifiers, Constructors, Static Methods, Data Hiding, Inheritance, Polymorphism, Operator Overloading, Abstract Classes. Exception Classes.

### Unit 5

**NumPy Library:** Introduction to NumPy, Creation of One-Dimensional Arrays, Reshaping of an Array, Element-wise Operations, Aggregate Operations, Array Indexing, Array Slicing, Insert Row/Columns, Append Row/Columns, Array Manipulation Operations, Multi-Dimensional Arrays.

**Pandas Library:** Data Preparation and Pre-Processing, Series, Querying a Series, DataFrames, DataFrame Indexing and Loading, Querying a Data Frame, Indexing Data Frames, Missing Values.



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**Data Visualization:** Graphs in Python: Bar charts, Pie-charts, Scatter plots, Multiple plots, Subplots, Legends, changing figure Size, Styling plots using Matplotlib Library.

### Lab Work

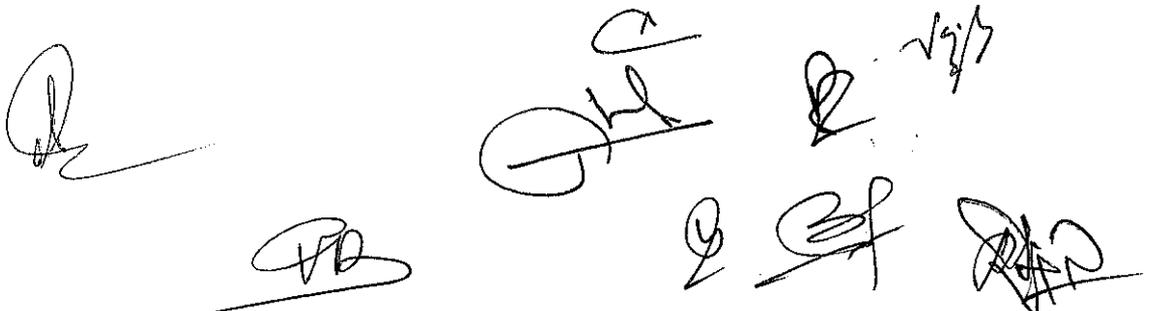
1. Case study to explore all the basic programming constructs in Python
2. Case study to implement various functionalities of a project using Python Function.
3. Case study to demonstrate different data structures in Python.
4. Case study to explore data from files using file handling in Python.
5. Case study to demonstrate different object-oriented concepts in Python.
6. A collaborative mini-project that uses different Libraries of python like Pandas, Numpy and Matplotlib

### Text and Reference Books

1. Budd T A, "Exploring Python", McGraw-Hill Education, 1st Edition, 2011.
2. Mark Lutz, "Learning Python", O'Reilly, 4th Edition, 2013.
3. Y. Daniel Liang, "Introduction to Programming Using Python", Pearson, 1st Edition, 2013.
4. Kenneth A. Lambert, "The Fundamentals of Python: First Programs". Cengage Learning, 1st Edition, 2011.
5. Allen Downey, "Think Python: How to Think Like a Computer Scientist", O'Reilly, 2nd Edition, 2015.
6. Reema Thareja, "Python Programming using Problem Solving Approach", Oxford University Press, 1st Edition, 2017.

### Course Outcomes

1. Demonstrate knowledge of basic programming constructs in Python.
2. Learn and Implement user defined functions and various packages of Python.
3. Illustrate string handling methods and data structure primitives like lists, tuples, sets and dictionaries in python.
4. Learn file handling and object- oriented programming techniques in python.
5. Evaluate and visualize the data using appropriate python libraries.



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## DATA SCIENCE (NCS-511)

C (L T P)

4 (3-1-0)

### Course Content

#### Unit 1

Introduction to core concepts and technologies: Introduction. Terminology, data science process, data science toolkit, Types of data, Example applications, Mathematical Foundations for Data Science: linear algebra; Analytical and numerical solutions of linear equations; Mathematical structures, concepts, and notations used in discrete mathematics. Introduction to Statistical Methods: basic and some advanced concepts of probability and statistics; Concepts of statistics in solving problems arising in data science.

#### 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.

#### 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.

#### Unit 4

Data visualization: Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, mapping variables to encodings. Visual encodings.

#### Unit 5

Pandas and NumPy: NumPy Basics - Fast Element wise array functions, Multidimensional Array, Data Processing using arrays, file i/o with arrays; Pandas - Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics, Handling Missing Data, Hierarchical Indexing.

### Text and Reference Books

1. R. V. Hogg, J. W. McKean and A. Craig, Introduction to Mathematical Statistics, 8th Ed., Pearson Education India, 2019.
2. Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science", Cambridge University Press, 2020.
3. Ani Adhikari and John DeNero, 'Computational and Inferential Thinking: The Foundations of Data Science', GitBook, 2019.
4. Python For Data Analysis (O Reilly, Wes McKinney), 2012.



### Course Outcomes

1. Understand the core concepts and methods in data science.
2. Understand the issues and challenges in data collection, storage, and management.
3. Understand and apply various techniques for data analysis.
4. Understand various data visualization techniques.
5. Understand Learn Python programming tools for data science.

PD                      A                      2/3/3

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# DATA WAREHOUSING & DATA MINING (NCS-513)

C (L T P)

4 (3-1-0)

## Course Content

### Unit 1

Data Warehousing and Business Analysis: - Data warehousing Components, building a Data warehouse, Mapping the Data Warehouse to a Multiprocessor Architecture, DBMS Schemas for Decision Support, Data Extraction, Cleanup, and Transformation Tools, Metadata reporting, Query tools and Applications, Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

### Unit 2

Data Mining: - Data Mining Functionalities – Data Preprocessing, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization, and Concept Hierarchy Generation.

Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods, Mining Various Kinds of Association Rules, Association Mining to Correlation Analysis, Constraint-Based Association Mining.

### Unit 3

Classification and Prediction: - Issues Regarding Classification and Prediction, Classification by Decision Tree Introduction, Bayesian Classification, Rule Based Classification, Classification by Backpropagation, Support Vector Machines, Associative Classification, Lazy Learners, Other Classification Methods, Prediction Accuracy and Error Measures, Evaluating the Accuracy of a Classifier or Predictor, Ensemble Methods, Model Selection.

### Unit 4

Cluster Analysis: - Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods, Hierarchical methods, Density-Based Methods. Grid-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data, Constraint-Based Cluster Analysis, Outlier Analysis.

### Unit 5

Mining Object, Spatial, Multimedia, Text, and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Spatial Data Mining, Multimedia Data Mining, Text Mining, Mining the World Wide Web.

## Text and Reference Books

1. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques" Second Edition, 2006.
2. Alex Berson and Stephen J. Smith, "Data Warehousing, Data Mining & OLAP", Tata McGraw Hill Edition, Tenth Reprint 2007.
3. G. K. Gupta, "Introduction to Data Mining with Case Studies", Eastern Economy

Edition, Prentice Hall of India, 2006.

4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Pearson Education, 2007.
5. Soman K.P., Shyam Diwakar and V. Ajay, "Insight into Data mining Theory and Practice", Eastern Economy Edition, Prentice Hall of India. 2006.
6. Daniel T. Larose, "Data Mining Methods and Models", Wile-Interscience; 2006.

### **Course Outcomes**

1. Understand the importance of abstraction of Knowledge from unstructured sources. (Understand)
2. Use of data pre-processing, cleaning, transformation, and integration for knowledge discovery and data mining principles. (Apply)
3. Understand classification and prediction in the areas of machine learning algorithms that underpin the knowledge discovery. (Understand)
4. Design data mining and data warehousing systems and solutions, to meet user requirements and specifications. (Apply, Analyze)
5. Use of multidimensional and web mining as techniques for extracting knowledge from a data warehouse. (Apply, Evaluate)

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# MULTIMEDIA SYSTEMS (NCS-515)

C (L T P)

4 (3-1-0)

## Course Content

### Unit 1

Introduction: Concept of Multimedia, Media & data stream, main properties of multimedia system, Data stream characteristics for continuous media, Multimedia Applications, Hardware Software requirements, Storage Technologies: RAID, Optical Media.

### Unit 2

Components of multimedia and file formats: Text, Basic sound concepts, MIDI, Speech, Basic concept of Images, Graphics format, Basic concepts of Video & animation, Conventional system, Computer based animation, Authoring Tools, Categories of Authoring Tools. Latest Web technologies, such as XML, X3D and Semantic Web.

### Unit 3

Compression Techniques: Lossless and Lossy compression, Run length coding, Statistical Coding, Transform Coding, JPEG, MPEG, Text compression using static Huffman technique, Dynamic Huffman Technique, Arithmetic Technique.

### Unit 4

Multimedia Communication: Stream characteristics for Continuous media – Temporal Relationship – Object Stream Interactions, Media Levity, Media Synchronization – Models for Temporal Specifications – Streaming of Audio and Video – Jitter – Fixed playout and Adaptive playout – Recovering from packet loss – RTSP – Multimedia Communication Standards – RTP/RTCP – SIP and H.263. Multimedia servers, databases and content management; Multimedia information system and applications.

### Unit 5

Wireless Multimedia Communication: End to End QoS provisioning in Wireless Multimedia Networks – Adaptive Framework – MAC layer QoS enhancements in Wireless Networks – A Hybrid MAC protocol for 10 Multimedia Traffic – Call Admission Control in Wireless Multimedia Networks – A Global QoS Management for Wireless Networks.

## Text and Reference Books

1. David Hillman, "Multimedia Technology & Applications", Galgotia Publications, 2000
2. Nigel Chapman & Jenny Chapman, "Digital Multimedia", Wiley Publications, 2000
3. D.P. Mukherjee, "Fundamentals of Computer Graphics and Multimedia", PHI, 2001
4. Nalin K Sharda, 'Multimedia Information Networking', Prentice Hall of India, 1999
5. Aura Ganz, Zvi Ganz and Kitti Wongthawaravat, 'Multimedia Wireless Networks: Technologies, Standards and QoS', Prentice Hall, 2003.
6. Ellen Kayata Wesel, 'Wireless Multimedia Communications: Networking Video, Voice and Data', Addison Wesley, 1998

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## Course Outcomes

1. Students will work with all aspects of images, videos and animation.
2. Define the basic concepts of image / video coding technology and compression standards
3. Describe the fundamentals of multimedia content, description and presentation.
4. Design the fundamentals of multimedia communication.
5. Explain the concept of wireless multimedia communication.

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- Bottom row: A signature on the left, a stylized 'B' in the center, and a signature on the right.

# WIRELESS AND MOBILE NETWORKS (NCS-517)

C (L T P)  
4 (3-1-0)

## Course Content

### Unit-1: Introduction

Wireless and Mobile Networks: History of different types of wireless technologies, Facts, Statistics, and Trends, Wireless Transmission: Signals, Antennas, Coding, Signal Propagation, Multiplexing, Modulation, Spread Spectrum, Introduction to Cellular systems, satellite systems, broadcast systems, Introduction to wireless LANs and technologies like Wi-Fi (IEEE 802.11), WiMAX (IEEE 802.16), Low-rate wireless personal area networks (IEEE 802.15), Bluetooth, Zigbee, LoRA and others.

### Unit-2: Cellular Network Foundations

Theoretical foundations in the core principles of modern cellular systems, Network planning techniques, Connectivity requirements analysis, Design of resource allocation mechanisms, Power control for fixed-rate and rate-adaptive systems. Wireless Medium Access Control: Common Problems, SDMA, FDMA, TDMA, CDMA. Wireless Telecommunications Systems: GSM, DECT, TETRA, UMTS, IMT-2000, LTE.

### Unit-3: Mobile Network Layer

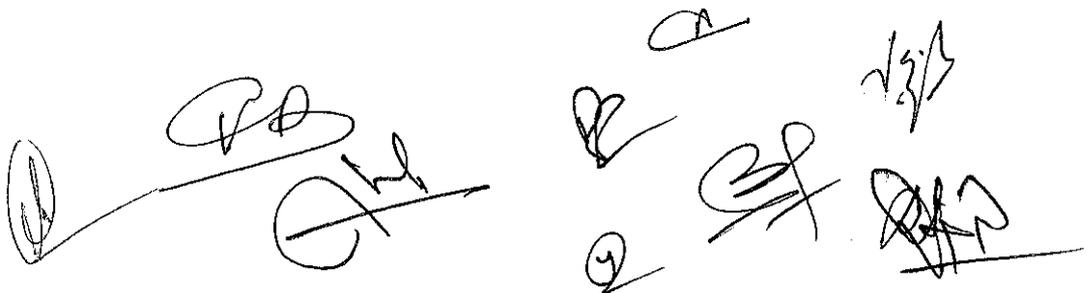
Issues and Problems of IP in Wireless Networks, Principles behind Mobile IP, Security issues and DHCP, Routing in Ad-hoc Networks and Wireless Sensor Networks: Need for routing and routing classifications, Table Driven Routing Protocols, Source Initiated On-Demand Routing Protocols, Hybrid Protocols – Zone Routing, Basic network performance metrics for evaluating and maintaining Quality of Service (QoS), Concepts and background to distinguish among various performance metrics for different wireless/mobile infrastructures.

### Unit-4: Mobile Transport Layer

Effects of mobility and wireless transmissions on reliable transport protocols such as TCP, Support for Mobility: File Systems, databases, WWW and Mobility, WAP, Application layer for mobile networks, Traditional TCP-Congestion Control, Slow start, Fast retransmit/fast recovery, Implications of mobility, Classical TCP, Indirect TCP, Snooping TCP, Mobile TCP, Transmission/time out freezing and advancements.

### Unit-5: Advanced Wireless Networks

Architecture and applications of Cellular, LTE, and 3G/4G/5G Systems, Wireless Broadband Networks-3G, Harmonized 3G, 3G CDMA, Smart Phones and 3G Evolution, 4G Vision, 4G features and challenges, Applications of 4G, 4G Technologies, 5G Wireless technologies, VANET: Connected and autonomous cars, Drone networking.



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## Text and Reference Books

1. J. Schiller, Mobile Communications, 2nd edition, Addison Wesley, 2008
2. Wireless Communications and Networks, William Stallings, 2nd edition, Prentice Hall, 2018.
3. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", Second Edition, Academic Press, 2008.
4. Anurag Kumar, D. Manjunath, Joy Kuri, Wireless Networking, First Edition, Elsevier 2011.
5. Simon Haykin, Michael Moher, David Koilpillai, Modern Wireless Communications, First Edition, Pearson Education 2013

## Course Outcomes

1. Understand various wireless LAN and Mobile Technologies available in the Mobile industry.
2. Understand the theoretical foundation and core principles of Wireless and Mobile Networks.
3. Study the issues and challenges in Mobile routing and various related protocols.
4. Study the issues and challenges in the mobile transport layer and various related protocols.
5. To get aware of state of art and latest industry standards in Wireless Mobile Networks.

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# MODELING AND SIMULATION (NCS-519)

C (L T P)  
4 (3-1-0)

## Course Content

### Unit-1: Introduction

Systems and system environment, Components of a system, Static and Dynamic systems, Discrete and continuous systems, Model of a system, Types of Models, Art and science of the modeling process, Simulation methods and Principles, Continuous, Discrete-Event and other System Simulation Techniques, Advantages and disadvantages of Simulation, Simulation examples: Simulation of queuing systems.

### Unit-2: Physical Modeling

Identify the key parameters of a model, estimate model outcomes, Dimensions analysis, Dimensionless grouping of input and output variables to find empirical relations, similarity criteria and their application to physical models, Modeling of System with Known Structure, Deterministic model, State Space Model, Transfer functions block diagram and sub-systems, Modeling for control.

### Unit-3: Random Processes and Queuing Models

Random process, Discrete/continuous time processes, Markovian property, Markov chain, State Transition Diagrams, Birth-death process, Little's theorem, Introduction to Queues and Random Noise, Random Variates Generation, Sensitivity Analysis, Steady state analysis of M/M/1 model; multi-server models, M/G/1 and other queuing models, Burke's theorem, a network of queues, Jackson theorem.

### Unit-4: Model Performance

Probability density and distribution functions, Location, scale and shape parameters, discrete and continuous probability distributions; Inverse transform method, composition and acceptance-rejection methods, efficiency and quality measures, Measures of performance and their estimation, Output analysis for terminating and steady-state simulations, Verification, Calibration, Validation and Optimization of models via Simulation.

### Unit-5: Simulation, Analysis and Viewing Tools

General structure and features of a simulation tool, Study of MATLAB as a simulation tool to describe the system syntax, define elementary representations, functions etc., Explain programming and the scripting process, e.g., relational operations, logical representations, condition statements, loops, etc., Create tabular and graphical and multidimensional visualization results. Various important tool boxes of MATLAB.

## Text and Reference Books

1. Law, A.M. and Kelton, W.D., "Simulation, Modeling and Analysis", 3rd Ed., Tata McGraw-Hill, 2003.

2. Banks, J., Carson, L.S., Nelson, B.L. and Nicol, D.M., "Discrete Event System Simulation", 4th Ed., Pearson Education, 2009.
3. Alberto Leon-Garcia, "Probability and Random Processes for Electrical Engineers", 2nd Ed., Pearson Education, 1998.
4. Network Simulation: SimEvent tool box in MATLAB, general features of network simulation packages, case study of OMNET++/ns2/ns3/NetSim, 2008.

#### Course Outcomes

1. Understand various components and models of the system.
2. Understand the theoretical foundation and core principles of Physical modeling.
3. Study the issues and challenges in Random Processes and Queuing Models.
4. Study of various measures of performance and their estimation for system modeling.
5. Study of various simulation tools to describe the system syntax, define elementary representations and functions.

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# SOFT COMPUTING (NCS-521)

C (L T P)  
4 (3-1-0)

## Course Content

### Unit-1

Introduction to Intelligent Systems and Soft Computing Characteristic behavior of Intelligent systems, Knowledge based systems, Knowledge Representation and Processing, Soft Computing characteristics, Constitutes of Soft Computing-Fuzzy Logic and Computing, Neural Computing, Evolutionary Computing, Rough Sets, Probabilistic Reasoning and Machine Learning.

### Unit-2

Neuro Computing - Supervised Learning Biological background, Pattern recognition tasks, Features of artificial neural networks, Activation functions, Perceptron model, Perceptron for classification and its limitations, Architectures of multilayer feed-forward neural networks, Back-propagation learning algorithm, Limitations of MLP.

### Unit-3

Neuro Computing - Unsupervised Learning Hebb's learning rule for competitive learning, Kohonen's self-organizing map and network topology, applications of SOM, Hopfield network and its topology, Boltzman Machines, Adaptive Resonance Theory.

### Unit-4

Fuzzy Logic and Fuzzy Systems Text and Reference Books: Course Outcomes: Course Content: Evolution of fuzzy logic, fuzzy sets, fuzzy logic operations, fuzzy relations, Fuzzy arithmetic and fuzzy measures. Fuzzy rules and reasoning, Fuzzy inference systems, Fuzzy modeling and decision making, Neuro-fuzzy modeling.

### Unit-5

Evolutionary Computing Biological background and Overview of evolutionary computing, Genetic algorithm and search space, Operators in genetic algorithm- encoding, selection, crossover, and mutation, Classification of GA, Evolutionary Programming and Strategies, Applications of fuzzy in pattern recognition character recognition. Applications of evolutionary computing in Image processing and computer vision, applications of soft computing in mobile ad-hoc networks, Information Retrieval, Semantic web, and Software Engineering.

### Text and Reference Books

1. Fakhreddine O. Karray, Clarence De Silva, 'Soft Computing and Intelligent systems design' Pearson Education, ISBN 978-81-317-2324-1, 1<sup>st</sup> ed., 2009.
2. B. K. Tripathy, J. Anuradha, 'Soft Computing: advances and applications', Cengage learning, ISBN-13: 978-81-315-2619-4.
3. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley publications, 2nd Edition, 2015.
4. J. S. R. Jang, C. T. Sun, E. Mizutani, 'Neuro-Fuzzy and Soft Computing- A computational



approach to Learning and Machine Intelligence' PHI, 1<sup>st</sup> ed., 1996.

5. David E. Goldberg, Genetic Algorithms - Pearson Education, 1<sup>st</sup> ed., 2006.

6. Satish Kumar, "Neural Networks - A Classroom Approach", Tata McGraw-Hill, 1<sup>st</sup> ed., 2009.

7. Weblink: (<https://nptel.ac.in/courses/106105173>)

### Course Outcomes

1. Understand differential behavior of Human and Intelligent Systems.
2. Understand and use supervised and un-supervised learning techniques in ANN.
3. Apply different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Network and their combination.
4. Analyze human-like processing in problem solving with current technologies in various domains like Bio Informatics, Multimedia Systems, Big Data Analytics, etc.
5. Design evolutionary computing techniques in real life problems.

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# ARTIFICIAL INTELLIGENCE (NCS-502)

C (L T P)  
4 (3-0-2)

## Course Content

### Unit-1: Introduction

Introduction to Artificial Intelligence, Various approaches to AI, Simulation of sophisticated & Intelligent Behavior, Intelligent Agents, Knowledge and its role in AI, Representing problems in state space, Heuristic algorithm versus solution guaranteed algorithms, Informed versus uninformed search, Production System Model, Soft computing versus Hard computing.

### Unit-2: AI-based Solution Strategies

Depth First Search and Breadth First Search, Heuristic Search Techniques: Hill Climbing, Best First search, A\* Algorithm, Branch and Bound, Cryptarithmic Problem, Means-End Analysis, Problem Reduction Technique, AND-OR Graphs, AO\* Algorithm, Game Playing: MINMAX Search, Alpha-Beta Pruning.

### Unit-3: Knowledge Representation and Reasoning

Propositional Logic, First Order Predicate Logic, Inference System in Propositional and Predicate Logic, Horn Clauses, Forward & Backward Deduction, Resolution Refutation, Reasoning under Uncertainty Associative Network, Semantic Networks, Conceptual Dependencies, Frames, Scripts, Case Grammar Theory.

### Unit-4: AI Applications

Understanding Natural Languages, Various Approaches of NLP, Parsing techniques, Context free and transformational grammars, Transition nets, Augmented transition nets, Fillmore's grammars, Grammar free analyzers, Sentence generation, and translation, Introduction to Pattern Recognition, Machine Learning, Perception, Object Identification, Speech Recognition etc.

### Unit-5: Expert Systems

Architecture of Expert System, Expert System Shell, Explanation System, Knowledge Acquisition System, Case study of Existing Expert Systems like DENDRAL, MYCIN, Development of a small Expert System using programming Languages and tools like LISP, PROLOG, JESS, Python.

### Lab Work

1. Write a program in prolog to solve Tower of Hanoi.
2. Write a program to implement Breadth First Search.
3. Write a program to implement Depth First Search.
4. Write a program to implement Hill Climbing Algorithm.
5. Write a program to implement A\*algorithm.

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6. Write a program to implement Tic-Toe Problem.
7. Write a program in prolog to solve 8-Puzzle Problem.
8. Write a program in prolog to solve 4- Queen Problem.
9. Write a program in prolog to solve Travelling Salesman Problem.
10. Write a program in prolog to solve Water Jug Problem.
11. Write a program to implement simple Chat Bot.

### Text and Reference Books

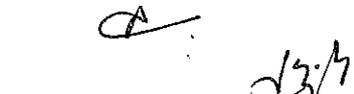
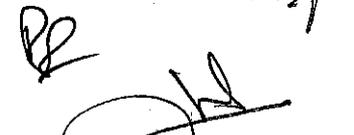
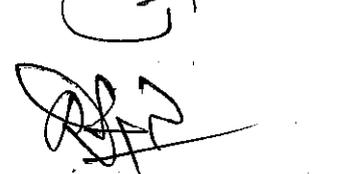
1. N. J. Nilsson, "Artificial Intelligence: A New Synthesis", Elsevier Publications, 1998.
2. Rich & Knight, "Artificial Intelligence", McGraw-Hill Publication, 2017.
3. D. W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI., 1990
4. Winston, "LISP Programming", Addison Wesley, 2015.
5. Marcellous, "Expert System Programming", PHI, 2018

### Course Outcomes

1. Understanding different types of AI agents (Understand).
2. Understand and apply various AI search algorithms (Understand, Apply).
3. Understand and apply the fundamentals of knowledge representation and reasoning process (Understand, Apply)
4. Apply AI concepts in a different domain (Apply)
5. Build simple knowledge-based AI/Expert systems using languages like LISP, Prolog, and AI tools like JESS. (Apply)


  
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# COMPUTER NETWORKS AND SECURITY (NCS-504)

C (L T P)  
4 (3-1-0)

## Course Content

### Unit-1

Introduction Concepts: Goals and Applications of Networks, Network structure and architecture, The OSI reference model, services, Physical Layer Transmission Media, Switching methods, Medium Access sub layer: Medium Access sub layer - Channel Allocations, LAN protocols - ALOHA protocols - Overview of IEEE standards.

### Unit-2

Data Link Layer - Elementary Data Link Protocols, Sliding Window protocols, Error Handling, Network Layer: Network Layer - Point-to-Pont Networks, routing, Congestion control Internetworking -TCP / IP - IP packet, IP address, IPv6.

### Unit-3

Transport Layer: Transport Layer - Design issues, connection management, session Layer-Design issues. Presentation Layer-Design issues, Application Layer: File Transfer, Access and Management, Electronic mail, Virtual Terminals.

### Unit-4

Security attacks, services and mechanism, cryptography. Conventional Encryption: Conventional encryption model, classical encryption techniques substitution ciphers and transposition ciphers, cryptanalysis, stereography, stream and block ciphers. Modern Block Ciphers: Block ciphers principals, Shannon's theory of confusion and diffusion, fiestal structuré, data encryption standard (DES), strength of DES, differential and linear cryptanalysis of DES, block cipher modes of operations, triple DES, key distribution.

### Unit-5

Prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms. Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffe-Hellman key exchange algorithm.

## Text and Reference Books

1. Forouzen, "Data Communication and Networking", Fourth Edition, TMH, 2007.
2. A.S. Tanenbaum, "Computer Networks", Third Edition, Prentice Hall India, 1997.
3. William Stallings, "Cryptography and Network Security: Principals and Practice", Fourth Edition, Pearson, 2006.

4. Atul Kahate, "Cryptography and Network Security", Third Edition, Mc. Graw Hill, 2014.
5. Johannes A. Buchmann, "Introduction to Cryptography", Springer-Verlag, 2001.
6. Bruce Schneier, "Applied Cryptography", Second Edition, Wiley, 2015.
7. S. Keshav, "An Engineering Approach on Computer Networking", Addison Wesley, 1997
8. W. Stallings, "Data and Computer Communication", Macmillan Press, 1989.
9. Oded Goldreich, "Foundations of Cryptography", Cambridge University Press, 2001.
10. Alfred J. Menezes, Paul C. Van Oorschot, Scott A. Vanstone, "A Handbook of Applied Cryptography", CRC Press, 1996.
11. Wembo Mao, "Modern Cryptography: Theory and Practice", Pearson Education, 2003.

### Course Outcomes

1. Understand and analyze the functions and working principles of wired and wireless local area networks. (Understand, Analyze)
2. Understand and analyze different routing algorithms. (Understand, Analyze)
3. Modify the existing protocols of TCP/IP protocol stack for performance improvement. (Apply, Analyze)
4. Understand and deploy cryptographic techniques to secure data in networks. (Understand, Apply)
5. Analyze the vulnerabilities in any computing system and design a security solution. (Apply, Analyze)

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## ADVANCED DATABASES (NCS-506)

C(L-T-P)  
4 (3-1-0)

### Course Content

#### Unit-1

Database System Applications Purpose of Database Systems, View of Data – Data Abstraction, Instances and Schemas, Data Models – the ER Model, Relational Model, Languages – DDL, DML, Transaction Management, Data Storage, Database Architecture, Database Users and Administrators, ER Model- ER Diagrams, Basic SQL Queries, Nested Queries, Complex Integrity Constraints in SQL, Triggers.

#### Unit-2

Relational Model: Introduction to the Relational Model – Integrity Constraints Over Relations, Enforcing Integrity constraints, Querying relational data, Logical database Design, Introduction to Schema Refinement – Functional Dependencies, Normal Forms – FIRST, SECOND, THIRD Normal forms, BCNF, Properties of Decompositions- Loss less- join Decomposition, Multi-valued Dependencies, FOURTH Normal Form, Join, Dependencies, FIFTH Normal form.

#### Unit-3

Transaction Management: The ACID Properties, Transactions and Schedules, Deadlocks, Concurrency Control: Serializability, and recoverability, Introduction to Lock Management, Lock

Crash recovery: Introduction to Crash recovery.

#### Unit-4

Overview of Storage and Indexing: Data on External Storage, File Organization and Indexing, Clustered Indexes, Primary and Secondary Indexes, Index data Structures, Hash-Based Indexing, Tree based Indexing, Storing data: Disks and Files: -The Memory Hierarchy

#### Unit-5

Distributed databases: Introduction to distributed databases, Distributed DBMS architectures, storing data in a distributed DBMS, Distributed catalog management, Distributed query processing Updating distributed data, Distributed transactions, Distributed concurrency control, and Distributed Recovery.

### Text and References Books

1. Data base Management Systems, Raghu Ramakrishnan, Johannes Gehrke, TMH, 3rd Edition, 2003.

2. Database System Concepts, A. Silberschatz, H.F. Korth, S. Sudarshan, McGraw hill, VI editions, 2006.
3. Fundamentals of Database Systems 5th edition. Ramez Elmasri, Shamkant B.Navathe, Pearson Education, 2008.
4. Introduction to Database Systems, C. J. Date, Pearson Education, 8<sup>th</sup> Edition, 2003
5. Database Management System Oracle SQL and PL/SQL, P. K. Dass Gupta, PHI, e-book, 2013.
6. Database System Concepts, Peter Rob & Carlos Coronel, Cengage Learning, 2008.

### Course Outcomes

1. Understand database systems, create ER models and write queries using relational algebra and SQL (understand, apply, analyze)
2. Create databases using Relational Model and normalizing databases to suitable normal forms (apply, analyze and create)
3. Understand the concept of transactions and concurrent transactions (understand, apply)
4. Understand and apply the data storage and indexing methods and study memory hierarchy (understand, apply, analyze)
5. Analyze various types of databases including distributed database environments (apply, analyze)

## CLOUD COMPUTING (NCS-512)

C (L T P)  
4 (3-1-0)

### Course Content

#### Unit-1: Overview of Computing Paradigm

Recent trends in Computing Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.

**Introduction to Cloud Computing** Cloud Computing (NIST Model) Introduction to Cloud Computing, Benefits of Cloud Computing.

#### Unit-2: Cloud Computing Architecture

Cloud computing stack Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services Service Models (XaaS) Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) Deployment Models Public cloud, Private cloud, Hybrid cloud, Community cloud.

#### Unit-3: Infrastructure as a Service (IaaS)

IaaS, virtualization, Different approaches to virtualization, Machine Image, Virtual Machine (VM) Resource Virtualization Server, Storage, Network Virtual Machine (resource) provisioning and manageability, storage as a service, Data storage in cloud computing (storage as a service).

**Platform as a Service (PaaS)** PaaS, Service Oriented Architecture (SOA) Cloud Platform and Management Computation Storage, SaaS, Web services.

#### Unit-4: Service Management in Cloud Computing

Service Level Agreements (SLAs), Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting enormously Managing Data Looking at Data, Scalability & Cloud Services Database & Data Stores in Cloud Large Scale Data Processing

#### Unit-5: Cloud Security

Infrastructure Security Network level security, Host level security, Application-level security Data security and Storage Data privacy and security Issues, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud.

### Text and Reference Books

1. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010.
2. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011.

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3. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012.
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010.

### Course Outcomes

1. Understand various basic concepts related to cloud computing technologies. (Understand)
2. Understand the architecture and concept of different cloud models: IaaS, PaaS, SaaS. (Understand)
3. Apply the underlying principle of cloud virtualization, cloud storage, data management and data visualization. (Apply)
4. Use different cloud service management terminologies. (Apply)
5. Design and deploy cloud computing security and risk measures (Analyze)

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# SOFTWARE REQUIREMENTS ENGINEERING AND RISK MANAGEMENT (NCS-514)

C (L T P)  
4 (3-1-0)

## Course Content

### Unit-1: Introduction

Software Engineering Processes, Definition, Role, and Importance of Requirements Engineering, Requirements Engineering Activities and Processes, Types of Requirements (Functional vs. Non-Functional), Techniques for Writing High-Quality Requirements, Requirements Inception, Elicitation, Evaluation, and Documentation, Software Requirements Specification (SRS) Documentation Standards and Templates.

### Unit-2: Requirements Analysis, Modeling, and Specification

Description vs. Specification, Modeling Techniques and Diagrammatic Notations, Domain Modeling, Use Case Modeling and Scenario Descriptions, UML Modeling, Analysis for Understanding the Domain and Requirements, and Formal Specification.

### Unit-3: Requirements Verification and Validation

Requirements Verification vs. Validation, Techniques for Inspection, Verification, and Validation, Detection of Conflicts, Inconsistencies, and Completeness, Quality Assurance for Requirements.

### Unit-4: Requirements Evolution and Management

Requirements Traceability, Priorities, Changes, Baselines, Reusing Requirements, foundation used to systematically establish, define, and manage the requirements for large, complex, and changing software-intensive systems from technical, organizational, and management perspectives.

### Unit-5: Advanced Topics

Hazard Analysis and Safety-Critical System Requirements, Threat Modeling and Security-Critical System Requirements, Tool Support for Requirements Engineering, Open Research Problems in Requirements Engineering.

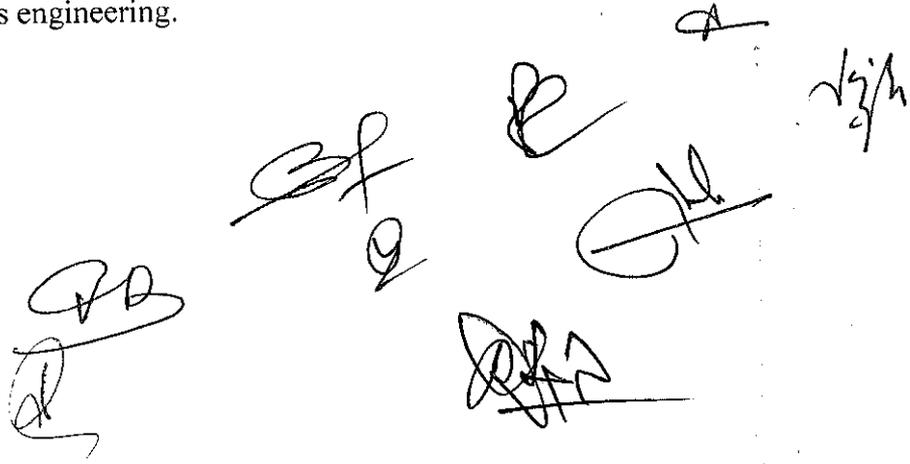
## Text and Reference Books

1. Requirements Engineering Fundamentals: A Study Guide for the Certified Professional for Requirements Engineering Exam - Foundation Level by Chris Rupp and Klaus Pohl, 2nd Edition, IREB Compliant, 2015.

2. Requirements Engineering by Jeremy Dick, Elizabeth Hull, and Ken Jackson, 4th Edition, Springer Publications, 2017.
3. Software Engineering: A Practitioner's Approach By Roger S. Pressman and Bruce Maxim McGraw-Hill Higher International; ISBN-10: 1259872971; ISBN-13: 978-1259872976, 9th Edition, 2014.
4. Software Engineering (10th Edition) by Ian Sommerville, Pearson; ISBN-10: 0133943038; ISBN-13: 978-0133943030, 2017.

### Course Outcomes

1. Understand the role of, and need for, requirements engineering and requirements elicitation, evaluation, documentation, and quality assurance.
2. Understand, prepare and use effective visual models, diagrams and notations in requirements analysis.
3. Describe and participate in requirements verification, validation, and traceability activities.
4. Prepare well-organized and maintainable software requirements documentation that can be reviewed, corrected, and (eventually) accepted by clients and stakeholders.
5. Create awareness about the latest and advanced tools and techniques of software requirements engineering.



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## DIGITAL IMAGE PROCESSING (NCS-516)

C (L T P)  
4 (3-1-0)

### Course Content

#### Unit-1: Digital Image Fundamentals

Introduction to Digital Image Processing and its components, Image Sensing and Acquisition, Sampling and Quantization, Relationships between pixels, Two-dimensional mathematical preliminaries, Image transforms – DFT, DCT.

#### Unit-2: Image Enhancement

Spatial Domain transforms: Gray level transformations, Histogram processing, Frequency Domain transforms: Fourier Transform, Smoothing and Sharpening, Spatial Filtering, Frequency Domain Filters – Gaussian Lowpass and High pass Filters, Ideal, Butterworth, and Homomorphic Filtering.

#### Unit-3: Image Restoration

Image Restoration – degradation model, Properties, Noise models, Mean Filters, Order Statistics Adaptive filters, Band reject Filters, Band-pass Filters, Inverse Filtering, Wiener filtering.

#### Unit-4: Image Segmentation

Point detection, Edge detection, Edge linking, and boundary detection, Hough Transform, Similarity-based segmentation – Thresholding, Region growing, Region splitting and merging, Morphological processing- Erosion and Dilation, Opening, Closing, Boundary Extraction, Convex Hull, Thinning, Thickening.

#### Unit-5: Image Representation and Description

Image Understanding techniques- Boundary-based, Region-based, Topological Attributes, Geometric Attributes Description Boundary-based Description, Region-based Description. Image processing research-based case study.

### Text and Reference Books

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing Pearson, Third Edition, 2010

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2. Digital Image Processing and Computer Vision, R.J. Schalkoff Published by: John Wiley and Sons, NY, 1989.
3. Anil K. Jain, Fundamentals of Digital Image Processing Pearson, 2002.
4. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson Education, Inc., 2011.
5. Kenneth R. Castleman, Digital Image Processing Pearson, 2006.
6. D, E. Dudgeon, and RM. Mersereau, Multidimensional Digital Signal Processing Prentice Hall Professional Technical Reference, 1990.
7. William K. Pratt, Digital Image Processing John Wiley, New York, 2002.

### Online Source

1. <https://in.coursera.org/specializations/image-processing>
2. <https://www.udemy.com/topic/image-processing/>
3. [https://onlinecourses.nptel.ac.in/noc19\\_ee55/preview](https://onlinecourses.nptel.ac.in/noc19_ee55/preview)
4. <https://www.mygreatlearning.com/academy/learn-for-free/courses/digital-image-processing>

### Course Outcomes

To explain the fundamentals of Image processing in terms of various research application-based components and to develop an understanding of various tools applied in different image processing fields.

At the end of this course, students should be able to:

CO1	<b>Analyze and apply</b> the sampling and quantization techniques for the conversion of an analog image into digital form.	Analyze and apply	K3
CO2	<b>Understand and apply</b> the concept of Image enhancement in both spatial and transform domains using various techniques.	Understand and apply	K1, K2
CO3	<b>Analyze and evaluate</b> the effects of various filters to restore the image degraded under a noisy environment.	Analyze and evaluate	K3, K4
CO4	<b>Understand and apply</b> different techniques for image segmentation and morphological operations to improve image quality.	Understand and apply	K1, K2
CO5	<b>Analysis</b> of various image representation and description methods and a brief discussion on tools and techniques in multidisciplinary research fields.	Analysis	K3

K1-Understand, K2-Apply, K3-Analyse, K4-Evaluate,

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## STORAGE AREA NETWORKS (NCS 518)

C (L T P)  
4 (3-1-0)

### Course Content

#### Unit 1

Introduction to evolution of storage architecture, key data centre elements, virtualization, and Cloud Computing. Key data centre elements – Host (or compute), connectivity, storage, and application in both classic and virtual environments. RAID implementations, techniques, and levels along with the impact of RAID on application performance. Components of intelligent storage systems and virtual storage provisioning and intelligent storage system implementations.

#### Unit 2

Storage Networking Technologies and Virtualization: Fibre Channel SAN components, connectivity options, and topologies including access protection mechanism ‘zoning’, FC protocol stack, addressing and operations, SAN-based virtualization and VSAN technology, iSCSI and FCIP protocols for storage access over IP network, Converged protocol FCoE and its components, Network Attached Storage (NAS) - components, protocol and operations, File level storage virtualization, Object based storage and unified storage platform.

#### Unit 3

Backup, Archive, and Replication: Information availability and business continuity solutions in both virtualized and non-virtualized environments. Business continuity terminologies, planning and solutions, Clustering and multipathing architecture to avoid single points of failure, Backup and recovery - methods, targets and topologies, Data deduplication and backup in virtualized environment, Fixed content and data archive, Local replication in classic and virtual environments, Remote replication in classic and virtual environments, Three-site remote replication and continuous data protection.

#### Unit 4

Cloud Computing Characteristics and benefits: Business drivers, definition, essential characteristics, and phases of journey to the Cloud., Business drivers for Cloud computing, Definition of Cloud computing, Characteristics of Cloud computing, Steps involved in

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transitioning from Classic data centre to Cloud computing environment Services and deployment models, Cloud infrastructure components, Cloud migration considerations.

### Unit 5

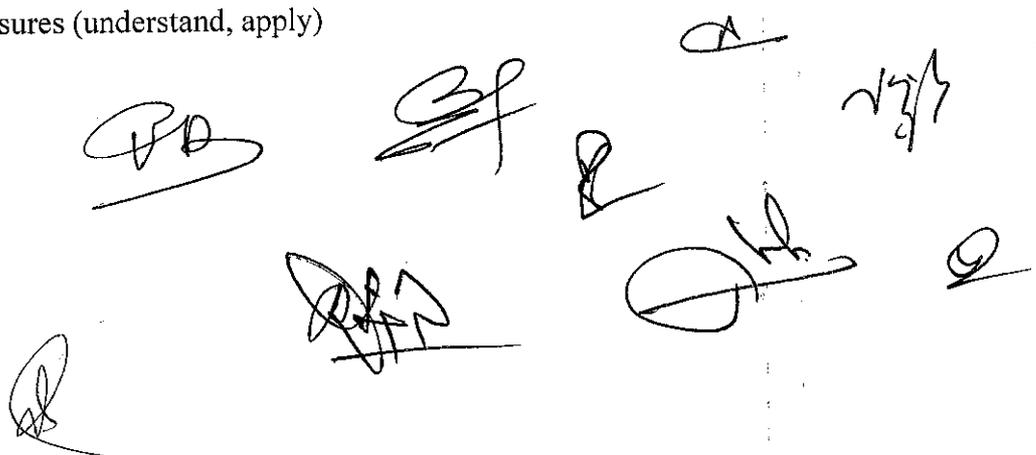
Securing and Managing Storage Infrastructure: Framework and domains of storage security along with covering security. Implementation at storage networking. Security threats, and countermeasures in various domains Security solutions for FC-SAN, IP-SAN and NAS environments, Security in virtualized and cloud environments, Monitoring and managing various information infrastructure components in classic and virtual environments, Information lifecycle management (ILM) and storage tiering, Cloud service management activities.

### Text and Reference Books

1. G. Somasundaram, A. Shrivastava, EMC Corporation: Information Storage and Management, 1st Edition, Wiley Publishing, 2009.
2. Clark Tom, Storage Virtualization, Addison Wesley Publishing Company, 2016.
3. Robert Spalding, Storage Networks: The Complete Reference, 1st Edition, TMH, 2003.
4. Meeta Gupta: Storage Area Network Fundamentals, 2nd Edition, Pearson Education Limited, 2002.

### Course Outcomes

1. Identify key challenges in managing information and analyze different storage networking technologies and virtualization (analyze, evaluate)
2. Explain components and the implementation of NAS (understand, apply)
3. Describe CAS architecture and types of archives and forms of virtualization (understand, apply)
4. Illustrate the storage infrastructure and management activities (evaluate)
5. Implementation of storage mechanism, understanding security threats and countermeasures (understand, apply)

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## REAL-TIME SYSTEMS (NCS-520)

C (L T P)  
4 (3-1-0)

### Course Content:

#### Unit-1: Introduction

Definition, Issues in Real-Time Computing, Structure of a Real Time System, RTS Examples, Characterizing Real-Time System and Tasks, Performance Measures for RTS, Estimating Program Run Time.

#### Unit-2: Real-Time Scheduling

Common Approaches to Real-Time Scheduling Algorithms, Allowing for Precedence Constraints, Offline Versus Online Scheduling, and Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems.

#### Unit-3: Resources Access Control

Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance, and Priority-Ceiling Protocols, Use of Priority-Ceiling Protocol in Dynamic n-Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Unit Resources, Controlling Concurrent Accesses to Data Objects, Real-Time Databases

#### Unit-4: Real Time Communication

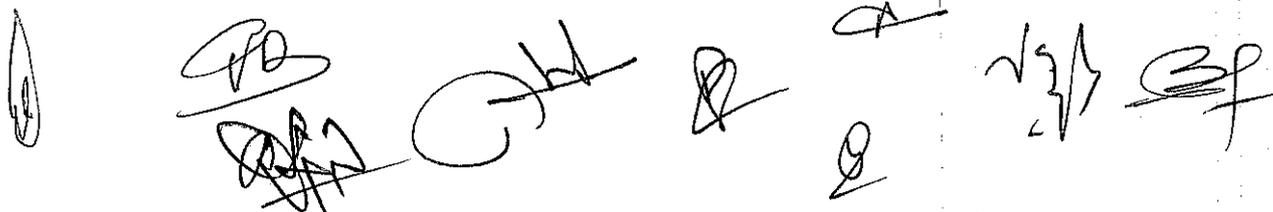
Network Topologies, Protocols, Real Time Communication over LAN and Internet, Routing, Resource Reservation, Traffic Shaping and Policing, Quality of Service Model.

#### Unit -5: Fault Tolerance Techniques

Introduction, what causes Failure, Fault types, Fault detection, Fault and error containment, Redundancy, Data Diversity, Reversal Checks, Malicious or Byzantine Failure, Integrated Failure Handling.

### Text and Reference Books

1. Real-Time Systems by Jane W. S. Liu, Pearson Education Publication, 2000.
2. Real-Time Systems: Scheduling, Analysis, and Verification by Prof. Albert M. K.

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Cheng, JohnWiley Publications. 2002.

3. Real-Time Systems, C.M. Krishna, Kang G. Shin, McGraw Hill.2017.

4. Real-Time Systems: Theory and Practice by Rajib Mall, Pearson.2006.

### Course Outcomes

1. Understand the characteristics of Real-Time Systems and their applications in various fields, (Understand)
2. Understand various Scheduling Algorithms for real-time systems and apply the appropriate one to prepare a feasible Schedule for a given task set. (Understand, Apply)
3. Apply precedence constraints and mutual exclusion constraints to a given Real-Time Schedule.(Apply)
4. Understand Distributed and Network related issues for Distributed Real-Time Systems.(Understand)
5. Understand various causes of Failures and Faults in Real-Time Systems and appreciate various techniques to avoid these faults and failures.

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## SOFTWARE METRICS AND QUALITY ASSURANCE (NCS-522)

C (L T P)  
4 (3-1-0)

### Course Contents

#### Unit 1

What Is Software Quality: Quality: Popular Views, Quality Professional Views, Software Quality, Total Quality Management and Summary. Fundamentals Of Measurement Theory: Definition, Operational Definition, And Measurement, Level of Measurement, Some Basic Measures, Reliability and Validity, Measurement Errors, Be Careful with Correlation, Criteria for Causality, Summary. Software Quality Metrics Overview: Product Quality Metrics, In Process Quality Metrics, Metrics for Software Maintenance, Examples for Metrics Programs, Collecting Software Engineering Data.

#### Unit 2

Applying The Seven Basic Quality Tools in Software Development: Ishikawa's Seven Basic Tools, Checklist, Pareo Diagram, Histogram, Run Charts, Scatter Diagram, Control Chart, Cause and Effect Diagram. The Rayleigh Model: Reliability Models, the Rayleigh Model Basic Assumptions, Implementation, Reliability and Predictive Validity.

#### Unit 3

Complexity Metrics and Models: Lines of Code, Halstead's Software Science, Cyclomatic Complexity Syntactic Metrics, An Example of Module Design Metrics in Practice. Metric And Lessons Learned for Object Oriented Projects: Object Oriented Concepts and Constructs, Design and Complexity Metrics, Productivity Metrics, Quality and Quality Management Metrics, Lessons Learned For object-oriented Projects.

#### Unit 4

Availability Metrics: Definition and Measurement of System Availability, Reliability Availability and Defect Rate, Collecting Customer Outage Data for Quality Improvement, In Process Metrics for Outage and Availability. Conducting Software Project Assessment: Audit Ad

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Assessment, Software Process Maturity Assessment and Software Project Assessment, Software Process Assessment a Proposed Software Project Assessment Method.

### Unit 5

Dos And Don'ts of Software Process Improvement: Measuring Process Maturity, Measuring Process Capability, Staged Versus Continuous Debating Religion, Measuring Levels Is Not Enough, Establishing the Alignment Principle, Take Time Getting Faster, keep it Simple or Face Decomplexification, Measuring the Value of Process Improvement, Measuring Process Compliance, Celebrate the Journey Not Just the Destination. Using Function Point Metrics to Measure Software Process Improvement: Software Process Improvement Sequences, Process Improvement Economies, Measuring Process Improvement at Activity Levels.

### Text and References books

1. Stephen H Khan: Metrics and Models in Software Quality Engineering, Pearson 2nd edition 2013.
2. Norman E-Fentor and Share Lawrence Pflieger." Software Metrics". International Thomson Computer Press, 1997.
3. S.A.Kelkar,"Software quality and Testing, PHI Learning, Pvt, Ltd., New Delhi 2012.
4. Watts S Humphrey, "Managing the Software Process", Pearson Education Inc, 2008.
5. Mary Beth Chrissis, Mike Konrad and Sandy Shrum, "CMMI", Pearson Education(Singapore), Pte Ltd, 2003
6. Philip B Crosby, " Quality is Free: The Art of Making Quality Certain ", Mass Market, 1992.

### Online Resources

1. <https://www.youtube.com/watch?v=KqDIuDubS-OU>
2. <https://www.udemy.com/topic/quality-assurance/>

### Course Outcomes

1. Understand and explain various concepts of Software Quality. (Understand)
2. Applying the Seven Basic Quality Tools in Software Development. (Apply)
3. Understand various concepts Complexity Metrics and Models. (Understand, Apply)
4. Understand Process Maturity Assessment and Software Project Assessment. (Understand).
5. Understand Dos and Don'ts of Software Process Improvement (Understand).



## MACHINE LEARNING (NCS-611)

C (L T P)  
4 (3-1-0)

### Course Content:

#### Unit-1

Introduction, Learning Paradigms, Ingredients of Learning, Designing a Learning System, The Concept Learning

#### Unit-2

Linear Regression: Single Variable and Multivariate, Cost Function, Parameter Learning: Gradient Descent and Analytical, Polynomial Regression, Logistic Regression Model, Regularization

#### Unit-3

Instance-based Learning: K-Nearest Neighbor Learning, Decision Tree Learning, Multiclass Classification, Evaluation of Hypothesis, Comparing Learning Algorithms

#### Unit-4

Neural Networks, Perceptron, Multilayer Perceptron, Introduction to Deep Learning, Bayesian Learning, EM Algorithm, HMM

#### Unit-5

Support Vector Machine, Kernel Machines, Unsupervised Learning: Clustering, Dimensionality Reduction, Reinforcement Learning, Q Learning, Activity Learning.

### Text and Reference Books

1. Tom. M. Mitchell, Machine Learning, McGraw Hill International Edition, 2017.
2. Pattern Classification - Duda, Hart and Stork (DHS), 2006.
3. Ethem Alpaydin, Introduction to Machine Learning. Eastern Economy Edition, Prentice Hall of India, 2015.
4. Bishop, C., Pattern Recognition and Machine Learning. Berlin: Springer-Verlag, 2016
5. The Elements of Statistical Learning - Hastie, Tibshirani, Friedman (HTF) 2017.

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## Course Outcomes

1. Learn the Machine Learning problems, and various paradigms to solve them
2. Understand Linear Regression and approaches to optimize a cost function
3. Apply and analyze various algorithms of KNN, Decision Tree based learning
4. Analyze the concept of neural networks for learning linear and non-linear activation functions.
5. Learn the concepts in Bayesian analysis from probability models and methods
6. Apply and analyze various algorithms for SVM, Reinforcement Learning, and Clustering.

## SOFTWARE PROJECT PLANNING AND MANAGEMENT (NCS-613)

C (L T P)  
4 (3-1-0)

## Course Content:

### Unit 1 Project Evaluation and Project Planning

Importance of Software Project Management, Activities, Methodologies, Categorization of Software Projects, Setting objectives, Management Principles, Management Control, Project portfolio Management, Strategic program Management, Stepwise Project Planning.

### Unit 2 Project Life Cycle and Effort Estimation

Software process and Process Models, Choice of Process models, Rapid Application development, Agile methods, Dynamic System Development Method, Extreme Programming, Managing interactive processes, Basics of Software estimation, Effort and Cost estimation techniques, COSMIC Full function points, COCOMO II - a Parametric Productivity Model.

### Unit 3 Activity Planning and Risk Management

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

### Unit 4 Project Management and Control

Framework for Management and control, Collection of data, Visualizing progress, Cost monitoring, Earned Value Analysis, Prioritizing Monitoring, Project tracking, change control – Software Configuration Management, Managing contracts, Contract Management.

### Unit 5 Project Management and Project Management Tools

Software Version Control, Risk Management: Risk and risk types, Risk Breakdown Structure, Risk Management Process: Risk identification, Risk analysis, Risk planning, Risk monitoring,

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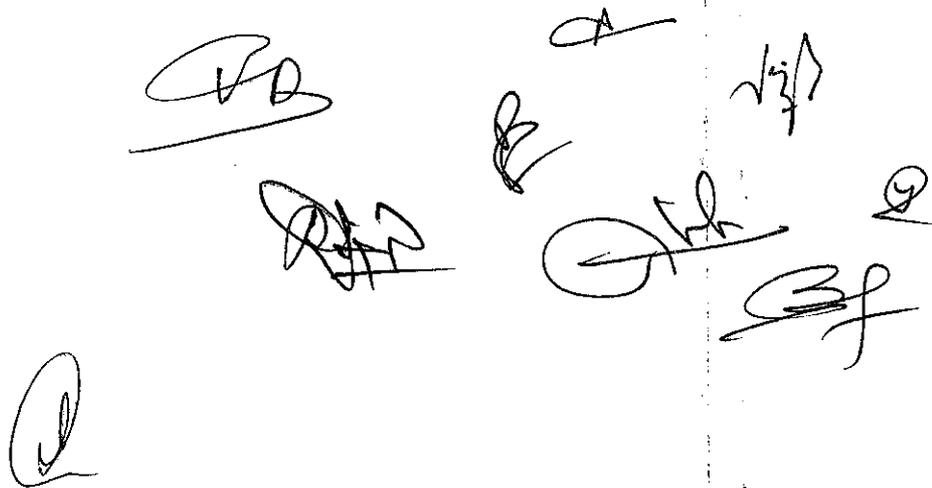
Cost Benefit Analysis, Software Project Management tools: CASE Tools, Planning and Scheduling Tools, MS-Project.

### Text and Reference Books

1. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, Tata McGraw Hill, New Delhi, 2012.
2. Robert K. Wysocki-Effective Software Project Management – Wiley Publication, 2011.
3. Walker Royce-Software Project Management- Addison-Wesley, 1998.  
Gopalaswamy Ramesh, -Managing Global Software Projects – McGraw Hill Education (India), Fourteenth Reprint 2013.

### Course Outcomes

1. Understand Project Management principles while developing software.
2. Gain extensive knowledge about the basic project management concepts, framework and the process models.
3. Obtain adequate knowledge about software process models and software effort estimation techniques.
4. Estimate the risks involved in various project activities.
5. Define the checkpoints, project reporting structure, project progress and tracking mechanisms using project management principles and management tools.



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## DIGITAL FORENSICS (NCS-615)

C (L T P)  
4 (3-1-0)

### Course Content

#### Unit-1

Evidential potential of digital devices: closed vs. open systems, evaluating digital evidence potential- Device handling: seizure issues, device identification, networked devices and contamination. Overview of Types of computer forensics i.e. Media Forensics, Network forensics (internet forensics), Machine forensic, Email forensic (e-mail tracing and investigations)

#### Unit-2

Digital forensics examination principles: Previewing, imaging, continuity, hashing and evidence locations- Seven element security model- developmental model of digital systems audit and logs- Evidence interpretation: Data content and context.

#### Unit-3

Live Data collection and investigating windows environment: windows Registry analysis, Gathering Tools to create a response toolkit (Built in tools like netstat, cmd.exe, nbtstat, arp, md5sum, regdmp, etc. and tools available as freeware like Fport, Pslist etc), Obtaining volatile Data (tools like coffee, Helix can be used) Computer forensics in windows environment, Log analysis and event viewer, File auditing, identifying rogue machines, hidden files and unauthorized access points

#### Unit-4

Live Data collection and investigating Unix/Linux environment: /Proc file system overview, Gathering Tools to create a response toolkit (Built-in tools like losetup, Vnode, netstat, df, md5sum, strace etc and tools available as freeware like Encase, Carbonite etc). Handling Investigations in Unix/Linux Environment: Log Analysis (Network, host, user logging details), Recording incident time/date stamps, Identifying rogue processes, unauthorized access points, unauthorized user/group accounts,

#### Unit-5

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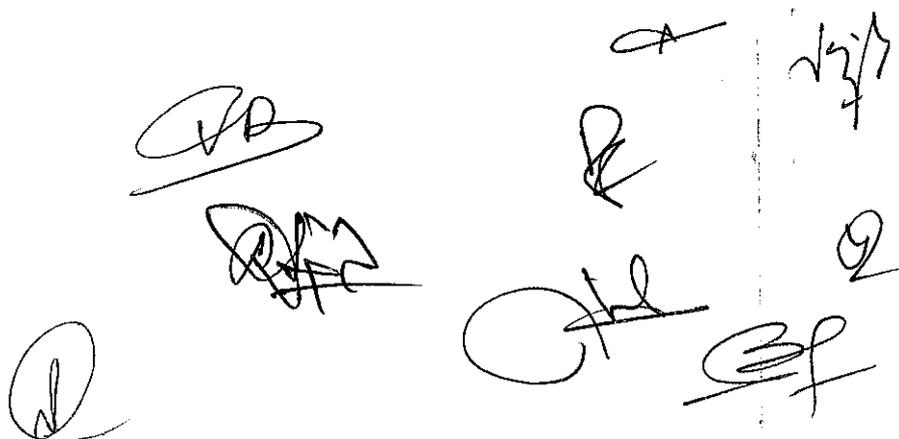
Forensic Tools and Report Generation: Recovery of Deleted files in windows and Unix, Analyzing network traffic, sniffers, Ethical Hacking, Hardware forensic tools like Port scanning and vulnerability assessment tools like Nmap, Netscan etc. Password recovery (tools like John the ripper, L0phtcrack, and THC-Hydra), Mobile forensic tools and analysis of called data record Template for computer forensic reports.

### Text and Reference Books

1. Incident Response & Computer Forensics. Mandia, k, Prosis, c, Pepe, m. 2nd edition. TataMcGraw Hill, 2003.
2. Guide to Computer Forensics and Investigations, 2nd edition. Bill Nelson, Amelia Phillips, Frank Enfinger, and Chris Steuart, Thomson Learning, 2009.
3. Digital Evidence and Computer Crime, 2nd Edition, Eoghan Casey , academic Press File System Forensic Analysis by Brian Carrier , addition Wesley, 2011.
4. Windows Forensic Analysis DVD Toolkit (Book with DVD-ROM), Harlan Carvey, syngress Publication, 2007.
5. EnCE: The Official EnCase Certified Examiner Study Guide, 2nd Edition, Steve Bunting, sybex Publication, 2004.

### Course Outcomes

1. To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
2. To understand how to examine digital evidences such as the data acquisition, identification analysis.
3. Know how to apply forensic analysis in Windows environment to recover important evidence for identifying computer crime.
4. Know how to apply forensic analysis in Linux/Unix environment to recover important evidence for identifying computer crime.
5. To be well-trained as next-generation computer crime investigators.



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## HIGH-PERFORMANCE NETWORKING (NCS-617)

C (L T P)  
4 (3-1-0)

### Course Contents

#### Unit-1: Introduction

Review of OSI, TCP/IP; Multiplexing, Modes of Communication, Switching, Routing, SONET, DWDM, DSL, ISDN, BISDN, ATM.

#### Unit-2: MULTIMEDIA NETWORKING APPLICATIONS

Streaming stored Audio and Video, Best effort service, protocols for real-time interactive applications, beyond best effort, scheduling and policing mechanism, integrated services, RSVP, differentiated services.

#### Unit-3: ADVANCED NETWORKS CONCEPTS

VPN, Remote-Access VPN, site-to-site VPN, tunneling to PPP, Security in VPN. MPLS operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS-based VPN, overlay networks-P2P connections.

#### Unit-4: TRAFFIC MODELLING

Little's theorem, Need for modeling, Poisson modeling and its failure, non-Poisson models, and Network performance evaluation.

#### Unit-5: NETWORK SECURITY AND MANAGEMENT

Principles of cryptography, Authentication, integrity, key distribution and certification, Access control and: firewalls – attacks and counter measures, security in many layers. Infrastructure for network management, The internet standard management framework, SMI, MIB, SNMP, Security and administration, ASN.1

### Text and Reference Books

1. J.F. Kurose & K.W. Ross, "Computer Networking- A top-down approach featuring the internet", Pearson, 2nd edition, 2003.
2. Walrand .J. Varatya, High performance communication network, Morgan Kauffman –

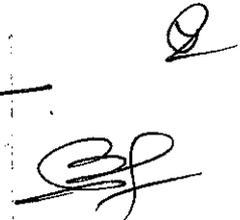


Harcourt Asia Pvt. Ltd. 2nd Edition, 2000.

3. LEOM-GarCIA, WIDJAJA, "Communication networks", TMH seventh reprint 2002.
4. Aunurag kumar, D. MANjunath, Joy kuri, "Communication Networking", Morgan Kaufmann Publishers, 1ed 2004.
5. Hersent Gurle & petit, "IP Telephony, packet Pored Multimedia communication Systems", Pearson education 2003.
6. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet" fifth edition, Pearson education, 2005.

### Course Outcomes

1. To develop a comprehensive understanding of multimedia networking
2. To study the types of VPN
3. Understand tunneling protocols for security
4. To apply network security in many layers
5. Understand and implement network management



## EMBEDDED SYSTEMS(NCS-619)

C (L T P)

4 (3-1-0)

### Course Contents:

#### Unit-1

Introduction to Embedded Systems: Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In-circuit emulator, Target Hardware Debugging.

#### Unit-2

Embedded Networking: Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols – RS232 standard – RS422 – RS485 – CAN Bus -Serial Peripheral Interface (SPI) – Inter-Integrated Circuits (I2C) –the need for device drivers.

#### Unit-3

Embedded Firmware Development Environment: Embedded Product Development Life Cycle objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object-oriented Model.

#### Unit-4

RTOS-Based Embedded System Design: Introduction to basic concepts of RTOS Task, process & threads, interrupt routines in RTOS, Multiprocessing, and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing-, Inter-process Communication.

#### Unit-5

Embedded System Application Development: Design issues and techniques Case Study of Washing Machine- Automotive Application- Smart card System Application.

### Text and References Books

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1. Wayne Wolf, 'Computers as Components: Principles of Embedded Computer System Design', Elsevier, 2006.
2. Michael J. Pont, 'Embedded C', Pearson Education, 2007.
3. Steve Heath, 'Embedded System Design', Elsevier, 2005.
4. Muhammed Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay, 'The 8051 Microcontroller and Embedded Systems', Pearson Education, Second edition, 2007.

#### Course Outcomes

1. Understand the basics of embedded systems and their structural units.
2. Analyze the embedded system specification and develop software programs.
3. Evaluate the requirements of the programming embedded systems and related software architecture.
4. Understand the RTOS-based embedded system design.
5. Understand all the applications of the embedded system and design issues.

### BIOINFORMATICS (NCS-621)

C (LTP)  
4 (3-1-0)

#### Course Contents

##### Unit 1

Primary and secondary databases. Specialized sequence databases of EST, TFB Sites, SNP's, gene expression. Pfam, PROSITE, BLOCK (Secondary databases). Data retrieval with ENTREZ, SRS, DBGET.

##### Unit 2

Principles of DNA sequencing (chemical chain termination, Dideoxy chain termination method, Automatic sequencer). RNA sequencing. Protein sequencing (Edmand degradation method)

##### Unit 3

Sequence alignment (pairwise and multiple, global and local). Sequence alignment algorithm (FAST, BLAST, Needleman and Wunsch, Smith Waterman). Database similarity searches (BLAST, FASTA and PSI BLAST). Amino acid substitution matrices (PAM BLOSUM)

##### Unit 4

Protein structure prediction (Chou Fasman method): Secondary and tertiary structures. Homology Modelling, ORF prediction, Gene prediction, Micro array data analysis. Profiles and motifs. 35

##### Unit 5

Structure visualization methods (RASMOL, CHIME etc.). Protein Structure alignment and analysis. Application of Bioinformatics in drug discovery and drug designing.

#### Text and Reference books

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1. Bioinformatics: Principles and applications by Ghosh and Mallick (oxford) university press), 2008.
2. Bioinformatics by Andreas D Boxevanis (Wiley), 4<sup>th</sup> Ed., 2020.
3. Fundamental concept of bioinformatics by Dan e. krane, 2002.
4. Introduction to bioinformatics by Attwood and Parry Smith (Pierson education Publication)
5. instant notes in Bioinformatics by Westhead, parish and Tweman (Bios scientific publishers.

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