Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)
Chennai, Tamil Nadu
India

35th BOS Meeting

with effect from
26.03.2022

M.Tech - Network Engineering

M.Tech (R16) - Curriculum

CBCS - Choice Based Credit System

Department of Computer Science and Engineering
School of Computing

M.Tech - Network Engineering

M.Tech (R16) – Curriculum

CBCS - Choice Based Credit System

Department of Computer Science and Engineering
School of Computing

Department of Computer Science & Engineering

VISION

To produce intellectual graduates who could contribute significantly in the analysis, design, development, operation and maintenance of complex software systems for meeting the ever changing requirements and to compete globally towards professional excellence.

MISSION

The mission of Computer Science and Engineering Department is to

M1: Design curricula for imparting training in adapting newer computing methods and technologies for providing effective and efficient solutions to the existing / new problems.

M2: Inculcate in-depth knowledge of various courses by employing Information and Communication Technology (ICT) based pedagogy methods.

M3: Create a conducive research environment for making technological innovations by the faculty and students.

M4: Provide leadership skills and professional ethics thereby making a prolific career in academics and industry.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs for M.Tech NE)

PEO1: Equip with Mastery of knowledge and competency in progressive areas of Network Engineering.

PEO2: Engage in professional and Ethical practices to foster the environmental and societal growth.

PEO3: Pursue the research in the Network Engineering and Participate Lifelong learning to adapt innovation.

PEO4: Lead and engage diverse teams through effective communication, inter-personal and project management skills.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO1. Independently carry out research / investigation and development work to solve practical problems.

PO2. Write and present a substantial technical report / document.

PO3. Demonstrate a degree of mastery in the area of Network Engineering to solve Network problems through relevant analytical methods and simulations.

PO4. Conceptualize and solve Network Engineering problems effectively and arrive at feasible optimal solution to accomplish a goal considering public health and safety, cultural, societal and environmental factors.

PO5. Apply Professional and ethical principles for developing intelligent and secure networks to accomplish sustainable development.

PO6. Exhibit knowledge of communication, leadership, and teamwork to manage projects in multidisciplinary environment and participate in Lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSO)

On successful completion of the program, the graduates will be able to,

PSO1: Formulate innovative and traceable solutions by modelling and Simulating the Network Topologies under realistic constraints.

PSO2: Apply Networking Principles and Protocols to design network hardware and software architecture to implement network applications.

M.Tech – NETWORK ENGINEERING

CBCS CURRICULUM

Honors / Specialization / Minor

(With effect from 2021-2022)

Minimum credits required for regular students in various course categories for M.Tech(NE)

The students shall earn 80 credits in various course categories given below for the award of degree of M.Tech (NE).

Course Category	Minimum Credits Required
Foundation Courses (FC)	4
Program Core (PC)	30
Program Elective (PE)	12
Independent Learning(IL)	8
Project Work	26
TOTAL	80

Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology
Department of Computer Science and Engineering
M. Tech Network Engineering - CBCS VTUR16

S. No	Subject Code	CBCS R-16		L	T	P	C	P.No
Foundation Course								
1.	2160MA102	Probability and Statistics	FC	4	0	0	4	8
Program Core								
2.	2161CS209	Advanced Data Structures and Algorithms	PC	3	0	2	4	11
3.	2161CS210	Modern Operating Systems	PC	3	0	2	4	14
4.	2161CS217	Advanced Data Base Management Systems	PC	3	0	2	4	17
5.	2161CS130	Parallel Computer Architecture	PC	3	0	0	3	21
6.	2161CS211	Software Engineering Principles and Practices	PC	3	0	2	4	23
7.	2161CS218	Advanced Computer Network	PC	3	0	2	4	26
8.	2161CS129	Machine Learning Techniques	PC	3	0	0	3	31
9.	2161CS304	Machine Learning Techniques Laboratory	PC	0	0	2	1	33
10.	2161CS141	Network Management	PC	3	0	0	3	35
Total Credits							**30**	
Program Specific Elective								
1	2162CS159	Evolutionary Computing Techniques	PE	3	0	2	4	39
2	2162CS117	Cryptography & Network Security	PE	3	0	0	3	42
3	2162CS116	Mobile and Pervasive Computing	PE	3	0	0	3	44
4	2162CS212	Software Defined Networks	PE	2	0	2	3	46
5	2162CS213	Network Programming	PE	2	0	2	3	50
6	2162CS214	Network Administration and Security	PE	2	0	2	3	54
Independent Learning								
1	2163MG401	Research Methodology	Independent Learning				2	

2	2163CS402	ICT Tools	Independent Learning	2
3	2163CS501	Research Seminar	Independent Learning (Anyone)	2
4	2163CS801	Field Study		
5	2163CS802	Internship		
6	2163GE401	Business Communication and Technical Writing	Independent Learning	2
Project Work				
1	2164CS601	Project Phase 1	Project Work	10
2	2164CS701	Project Phase 2	Project Work	16

L – Lecture; T – Tutorial; P – Practical; C – Credit

FOUNDATION COURSE

COURSE CODE	COURSE TITLE	L	T	P	C
2160MA102	Probability and Statistics	4	0	0	4

A. Preamble

To provide an in-depth knowledge about probability, sampling, Correlation and Random process

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- Be familiar with the basic concepts of probability and random variables.
- Understand the basic concepts of sampling distribution.
- Develop the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- Apply the Correlation and classifications of design of experiments for statistical quality control.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Understand the basic concepts of probability	K2
CO2	Apply the basic concepts of different types of sampling	K3
CO3	Utilize the concepts of Hypothesis testing and Chi-square testing to solve simple problems	K3
CO4	Demonstrate the concepts of Correlation	K3
CO5	Develop the concepts of Random process to solve simple problems	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M			M			M	M
CO2	M			M			M	M
CO3	M			M			M	M
CO4	M			M			M	M
CO5	M			M			M	M

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 INTRODUCTION L-9 Hours

Axioms of probability - Conditional probability - Total probability - Baye's theorem - Random variable - Probability mass function - Probability density function – Properties – Moments - Moment generating function and their properties - Binomial, Poisson, Geometric, Negative binomial, Uniform, Exponential, Gamma and Weibull distribution and their properties.

UNIT 2 SAMPLING L-9 Hours

Sampling: different types of sampling – Sampling distribution – Sampling distribution of Mean Point Estimation of parameters: general concepts of Estimation – Unbiased estimators – Variance of a point Estimator – Standard error – Method of point estimation (method of moments – method of maximum likelihood) – Statistical intervals for a single sample: confidence interval on the mean of a normal distribution with variance known – Confidence interval on the mean of a normal distribution with variance unknown – Confidence interval on the variance and standard deviation of a normal distribution

UNIT 3 TESTING OF HYPOTHESIS L-9 Hours

Hypothesis testing: one sample and two sample tests for means and properties of large samples (z-test), one sample and two sample tests for means of small samples (t-test), F-test for two sample standard deviations – Chi-square test for single sample standard deviation – Chi-square tests for independence of attributes and goodness of fit.

UNIT 4 CORRELATION AND REGRESSION L-9 Hours

Correlation – Scatter diagram – Karlpearson coefficient of correlation – calculation of the correlation coefficient for a bivariant frequency distribution – rank correlation – repeated rank – Regression – lines of regression – regression curves – regression coefficients – multiple and partial correlation – coefficient of partial correlation – generalization – multiple correlation.

UNIT 5 RANDOM PROCESSES L-9 Hours

Classification – Stationary process – Markov Process – Poisson process – Discrete parameter – Markov chain – Chapman Kolmogorov equations – Limiting distributions.

Total : 45 Hours

G. Learning Resources (in IEEE Format)

i. Text Books:

1. Richard A. Johnson and C. B. Gupta, Probability and Statistics for Engineers, (7th Edn.), Pearson Education, Indian Impression – 2011 (Unit 1 to 5)

ii. Online References:

1. Course on "Probability and statistics" Dec 2021[online], Available: https://nptel.ac.in/courses/111/105/111105090
2. Course on "Probabilities and Statistics course ",Dec 2021[online], Available: https://stanford.edu/~shervine/teaching/cs-229/refresher-probabilities-statistics

PROGRAM CORE

COURSE CODE	COURSE TITLE	L	T	P	C
2161CS209	Advanced Data Structures and Algorithms	3	0	2	4

A. Preamble

To provide an in-depth knowledge in problem solving techniques and data structures

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- Develop skill in formulate, design and analyze algorithms for problem statements.
- Choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem.
- Understand the necessary mathematical abstraction to solve problems.
- Comprehend and select algorithm design approaches in a problem specific manner.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Understand various concepts of trees structures, Hashing	K2
CO2	Apply the depth knowledge of Disjoint sets	K3
CO3	Illustrate some of the advanced algorithms in graphs	K2
CO4	Demonstrate the depth knowledge of NP completeness and string-matching algorithms.	K2
CO5	Make use of knowledge of Randomized Algorithms	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M						M	
CO2			H	M			M	
CO3	M		M	H			M	
CO4	M		H	M			M	
CO5	M	M	H	M			M	

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 ELEMENTARY DATA STRUCTURES L-9 Hours

Probabilistic Analysis, Amortized Analysis, Competitive Analysis, Hash tables: Direct Addressing, Functions and tables, Open addressing, Perfect Hashing, Red-Black Trees, Splay Trees, Augmented Data Structures

UNIT 2 ADVANCED DATA STRUCTURES L-9 Hours

B-trees, Fibonacci heaps, Van Emde Boas Trees, Data Structures for Disjoint Sets.

UNIT 3 GRAPHS & ALGORITHMS L-9 Hours

Representation, Maximum Flow-Flow networks, The Ford-Fulkerson method , Maximum bipartite matching ,Push-relabel algorithms ,The relabel-to-front algorithm. .

UNIT 4 STRING MATCHING AND APPROXIMATION ALGORITHMS L-9 Hours

String Matching Algorithms: Rabin-Karp, Knuth-Morris-Pratt, String Matching with finite automata-Approximation algorithms: Need of approximation, Introduction to P, NP, NP-Hard and NP-Complete; Vertex Cover problem, TSP, Set Cover, Subset sum Problem.

UNIT 5 RANDOMIZED ALGORITHMS L-9 Hours

Introduction, Type of Randomized Algorithms, Min- Cut, 2- SAT; Game Theoretic Techniques, Random Walks.

Total : 45 Hours

G. Laboratory of Experiments Total : 30 Hours

TASK 1	Create a hash table and perform open addressing for a set of values. **Tools: C/ C++/Python/Java**
TASK 2	For a given graph perform graph coloring. **Tools: C/ C++/Python/Java**
TASK 3	Create a Btree for a given set of values and perform insert and delete operations. **Tools: C/ C++/Python/Java**
TASK 4	Perform two types of rotations in Red Black Tree. **Tools: C/ C++/Python/Java**
TASK 5	Find out the Maximum flow and Minimum cut in a graph for any given number of nodes. **Tools: C/ C++/Python/Java**
TASK 6	Implement string matching by Rabin-Karp Algorithm. **Tools: C/ C++/Python/Java**
TASK 7	Implement string matching by Knuth-Morris-Pra Algorithm. **Tools: C/ C++/Python/Java**
TASK 8	Solve TSP for a given graph. **Tools: C/ C++/Python/Java**
TASK 9	Solve Set Cover Problem for given set of elements. **Tools: C/ C++/Python/Java**
TASK 10	Write a program to solve subset sum. **Tools: C/ C++/Python/Java**

Total: 75 Hours

H. Learning Resources (in IEEE Format)

i. Text Books:

1. Thomas Coremen, “Introduction to Algorithms”, Third edition, Prentice Hall of India – 2009. (Unit 1– 4).
2. Motwani R., Raghavan P., “Randomized Algorithms”, Cambridge University Press, 1995.(Unit 5)

ii. Reference Books:

1. Kleinberg J., Tardos E., "Algorithm Design", 1st Edition, Pearson, 2012.
2. Vazirani, Vijay V., "Approximation Algorithms", Springer, 2001.
3. Floyds L.R,"Graph Theory Applications ", Springer, 1994.

iii. Online References:

1. Course on “Advanced Data Structures and Algorithms ”, Dec 2021, Available: https://nptel.ac.in/courses/106/102/106102064/
2. Course on “Data Structures and Algorithms Specialization course” Jan 2022 , Available : https://www.coursera.org/specializations/data-structures-algorithms

COURSE CODE	COURSE TITLE	L	T	P	C
2161CS210	Modern Operating Systems	3	0	2	4

A. Preamble

To provide an in-depth knowledge in operating system concepts

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- Be familiar with the concepts of synchronization problems.
- Characterize the kinds of algorithms and process management in distributed Operating system.
- Apply the dead lock in distributed Operating system.
- Demonstrate skills in fault tolerance and familiar with the design issues in real time OS

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K – Level
CO1	Understand the various types of operating systems and synchronization problems.	K2
CO2	Outline the algorithms to manage and process Distributed OS	K2
CO3	Apply the concepts of Deadlocks in distributed OS	K3
CO4	Develop the concepts of fault tolerance in distributed OS.	K3
CO5	Explain the design issues of Real time OS.	K2
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M		M				M	M
CO2	M		M				M	M
CO3	M		M	M			M	M
CO4	M		M	M	M		M	M
CO5	M	H	M	M	M		M	M

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 FUNDAMENTALS OF OPERATING SYSTEMS **L-9 Hours**

Overview – Synchronization Mechanisms – Processes and Threads - Process Scheduling– Deadlocks: Detection, Prevention and Recovery – Models of Resources – Memory Management Techniques.

UNIT 2 DISTRIBUTED OPERATING SYSTEM **L-9 Hours.**

Scheduling: Issues in load distributing, Components of load distributing algorithms, Stability, Load distributing algorithms, Performance Comparison, Selecting load sharing Algorithm-Synchronization: Physical and logical clocks -Distributed Mutual Exclusion: Mutual Exclusion algorithms and its classification.

UNIT 3 DISTRIBUTED DEADLOCK HANDLING **L-9 Hours**

Introduction, deadlock handling strategies, detection: Issues and resolution, Control Organizations, Centralized algorithms, Distributed algorithms, Hierarchical algorithms.

UNIT 4 DISTRIBUTED FAULT HANDLING **L-9 Hours**

Agreement Protocol: System Model, Classification, solution to Byzantine Agreement Problem- Fault Recovery: Concepts, Classification of failures, Backward error recovery, Recovery in concurrent Systems, Consistent Check Points, Synchronous and Asynchronous check pointing and recovery-Fault tolerance: Issues, Atomic actions and committing, Commit Protocols, Non-blocking Commit protocols, Voting protocols and Dynamic Voting Protocol.

UNIT 5 REAL TIME OPERATING SYTEMS **L-9 Hours**

Types of Real time tasks, Timing Constraints, Modeling Timing Constraints-Task Scheduling: Types of tasks and their characteristics, Clock driven Scheduling, Hybrid Schedulers, Event driven Scheduling, EDF Scheduling, Rate Monotonic Algorithm - Resource Handling: Resource Sharing, Priority Inversion, PIP, PCP, HLP.

Total : 45 Hours

G. Laboratory Experiments

Total : 30 Hours

TASK 1	Implement the Mutual Exclusion Problem Using Dekker's Algorithm. **Tools: C/C++/ Java**
TASK 2	Implement Inter Process Communication Problem (Producer-Consumer / Reader- Writer Problem) Using Semaphores. **Tools: C/C++/ Java**
TASK 3	Implement Banker's algorithm. **Tools: C/C++/ Java**
TASK 4	Implement and study the incremental/decremented growth of response and service times for different number of client and servers for servicing continuous stream(s) of constant sized messages. **Tools: C/C++/ Java**
TASK 5	Implement a name server for registration and identification of services

	running on another server. **Tools: C/C++/ Java**
TASK 6	Implement a client-server application for a computing problem (of exponential complexity).Compare the performance for a loscal and remote machine of different speeds. **Tools: C/C++/ Java**
TASK 7	Implement a fault tolerant client and server application using the concept of name server. The client incorporates fault tolerant by sending a service request to another server using name server, if the current server fails to respond within 10 seconds. **Tools: C/C++/ Java**
TASK 8	Implement a stateful server for a transaction consisting of mainly four operations viz. open a file, close opened file, read from opened file and write to opened file. The state of file operation is maintained at stateful server. **Tools: C/C++/ Java**
TASK 9	Schedule the task set using e Rate-Monotonic scheduling algorithm. **Tools: C/C++/ Java**
TASK 10	Schedule the task set using EDF Scheduler. **Tools: C/C++/ Java**

Total: 75 Hours

H. Learning Resources (in IEEE Format)

i. Text Books:

1. Mukesh Singhal, Niranjan G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", MC Graw Hill education, 2001.(Unit 1-4)
2. Rajib Mall, “Real-Time Systems: Theory and Practice”, Pearson education, 2008. (Unit -5)

ii. Reference Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, “Operating System Concepts”, Seventh Edition, John Wiley & Sons, 2004.
2. Andrew S.Tanenbaum, “Modern Operating System”, Pearson Edition, Thrid Edition, 2009.

iii. Online References:

1. Course on “Power of Operating system” ,Jan 2022 [online], Available: https://www.coursera.org/learn/os-power-user
2. Course on “Operating Systems and You: Becoming a Power User” , Dec 2021 [online],Available: https://nptel.ac.in/courses/106/105/106105214/

COURSE CODE	COURSE TITLE	L	T	P	C
2161CS217	Advanced Data Base Management Systems	3	0	2	4

A. Preamble

To provide an in-depth knowledge about how database systems are maintain, manage and mitigate the current real world scenarios via distributed databases, multi version concurrency control, summarizing and provide statistic based decision-making with huge databases like warehouses, big data. This course also provides a basic mining terminologies like rule mining and clustering

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to\

- Describe the fundamental elements of relational database management systems
- Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
- Design ER-models to represent simple database application scenarios
- Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Outline the basic OO concepts underlying databases	K2
CO2	Relate object-oriented databases and ODMG model	K2
CO3	Explain the concurrency control through parallel and distributed databases	K2
CO4	Describe the decision-making process in warehouse and through mining process	K2
CO5	Apply the modern data models relating to real time scenarios	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	**M**		**M**				**M**	**M**
CO2	**M**		**M**				**M**	**M**
CO3	**M**		**M**				**M**	**M**
CO4	**M**		**M**	**M**	**M**	**M**	**M**	**M**
CO5	**M**		**M**	**M**	**M**	**M**	**M**	**M**

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 REVIEW OF RELATIONAL DATA MODEL AND OODBS L-9 Hours

Relational model concepts; Relational model constraints and relational database schemas; Update operations, anomalies, dealing with constraint violations, Types and violations. Overview of Object-Oriented Concepts – Objects, Basic properties. Advantages, examples, Abstract data types, Encapsulation, class hierarchies, polymorphism, examples.

UNIT 2 OBJECT AND OBJECT-RELATIONAL DATABASES L-9 Hours

Overview of OOP; Complex objects; Identity, structure etc. Object model of ODMG, Object definition Language ODL; Object Query Language OQL; Conceptual design of Object database. Overview of object relational features of SQL; Object-relational features of Oracle; Implementation and related issues for extended type systems; syntax and demo examples, The nested relational model. Overview of C++ language binding; Mongoose- Object relational features-CRUD operations in Mongoose environment;

UNIT 3 PARALLEL AND DISTRIBUTED DATABASES L-9 Hours

Architectures for parallel databases; Parallel query evaluation; Parallelizing individual operations; Parallel query optimizations; Introduction to distributed databases; Distributed DBMS architectures; Storing data in a Distributed DBMS; Distributed catalog management; Distributed Query processing; Updating distributed data; Multi Version Concurrency Control, Sharding; Distributed transactions; Distributed Concurrency control and Recovery; MVCC with PostgreSQL and SQLite.

UNIT 4 DATA WAREHOUSING, DECISION SUPPORT AND DATA MINING L-9 Hours

Introduction to decision support; OLAP, multidimensional model; Window queries in SQL; Finding answers quickly; Implementation techniques for OLAP; Data Warehousing; Views and Decision support, View materialization, Maintaining materialized views. Introduction to Data Mining; Counting co-occurrences; Mining for rules; Tree-structured rules; ROC and CMC Curves; Clustering; Similarity search over sequences; Incremental mining and data streams; Additional data mining tasks.

UNIT 5 ENHANCED DATA MODELS FOR SOME ADVANCED APPLICATIONS L-9 Hours

Active database concepts and triggers; Temporal, Spatial, and Deductive Databases – Basic concepts. More Recent Applications: Mobile databases; Multimedia databases; Geographical Information Systems; Genome data management. NoSQL with Object Oriented Concepts-MongoDB-Mongoose; Graph databases- Neo4j- CRUD operation using Neo4j; Neo4j vs GraphQL; Query modelling using GraphQL; Handling Big Data using MongoDB-Map Reduce using MongoDB-Hadoop Node configuration.

Total: 45 Hours

G. Laboratory Experiments — Total : 30 Hours

Part-1

TASK 1	Designing databases using Postgres and SQLite **Tools: SQL Server Management Studio (SSMS)**
TASK 2	Performing Equivalent queries using Oracle for simple clauses and operators like having, group by; like, is, as, in, not in; < ,> ; and, or; **Tools: SQL Server Management Studio (SSMS)**
TASK 3	Performing equivalent queries for nested and join queries using join..with ,join..in, using SQLite
TASK 4	Reporting logs of listener controls using listctl of Oracle SQL **Tools: SQL Server Management Studio (SSMS)**
TASK 5	Performing Multi version concurrency control using Snapshot using Oracle SQL
TASK 6	Making Java GUI and performing OO transactions using Postgres and SQLite **Tools: SQL Server Management Studio (SSMS)**
TASK 7	Designing QBE design performing CRUD operations in postgres and SQLite queries. **Tools: SQL Server Management Studio (SSMS)**
TASK 8	Devising Cursors for coherence control of database objects. **Tools: SQL Server Management Studio (SSMS)**
TASK 9	Devising Cluster partitions using Oracle SQL for Schemas. **Tools: SQL Server Management Studio (SSMS)**
TASK 10	Performing Cluster partitions or map reduce using MongoDB. **Tools: MongoDB**
TASK 11	Performing CRUD operations using MongoDB **Tools: MongoDB**
TASK 12	Performing CRUD operations using GraphQL/Neo4j

Part-2

Use Case-1: Building a Cart analysis for Myph

Myph has just launched their brand new phone range to the eager reception of the consumer market cart analysis. The product's data model has a unique menu that identifies the product, title, description, a stock quantity, and pricing information about the item. All products have categories. To be able to provide a list of all the products in a category, amend the data model with a collection of documents for each category and contain the path for that category in the category tree. Use cart analysis in developing different consumer selection options. Would this answer outlier selection in cart i.e., surplus selections? Is Relational database application can answer these transactions? How recovery is made through carting and commerce?

Use Case-2: Indexing various devices in IoT platform

A generic IoT platform required support for data from a wide range of devices, some of which could not be envisaged while developing the platform. The proficient work necessitated a data storage mechanism that could handle data from different types of devices. Indexing support makes it easy to pull data using a single index or multiple indexes such as device id with location id. Records for a particular device in different locations are easily accessed. Common parameters like temperature from different types of devices and their records are retrieved fast through these indexes. How the application could lead to the choice of JSON-based document database, MongoDB? Assume or create JSON script in support of this.

Total: 75 Hours

H. Learning Resources (in IEEE Format)

i. G.Text Books:

1.J.D.Ullmann et al, "Database Systems: The Complete Book", Second Edition, Pearson Ed, Inc, 2009.[Unit 1-5]

ii. Reference Books:

1.Shannon Bradshaw, E Brazil, Kristina Chodorow, "MongoDB: The Definitive Guide - Powerful and Scalable Data Storage", Third Edition, Shroff/O'Reilly Inc., January 2020.[Unit-5]

2.AgusKurniawin, “Python and SQLite Development”, First Edition, PE Press, January 2021. [unit-5]

3.Stephano Ceri and Giusepe Pelagatti,“Distributed databases: Principles & Systems”, Mc Graw Hill (India) Pvt Ltd, 2017

iii. Online References:

1. “Designing local library models”, Accessed on: May 05, 2021[online]. Available: https://developer.mozilla.org/en-US/docs/Learn/Server-side/Express_Nodejs/mongoose.
2. Vivian Siahaan and Rismon Hasiholan Sianipur,” The fast way to learn Java GUI with PostgreSQL and SQLite”, Accessed on : October 27,2021 [online]. Available: https://www.google.co.in/books/edition/The_Fast_Way_to_Learn_Java_GUI_with_Post/uPvJDwAAQBAJ?hl=en&gbpv=1&dq=sqlite&printsec=frontcover.
3. iii.Michael Hunger, Ryan Boyd & William Lyon, “The Definitive Guide to Graph Databases for the RDBMS Developer”, first Ed, E-book, Accessed on: October 27, 2021 [online & Download]. Available: https://neo4j.com/whitepapers/rdbms-developers-graph-databases-ebook/

COURSE CODE	COURSE TITLE	L	T	P	C
2161CS130	Parallel Computer Architecture	3	0	0	3

A. Preamble

To provide an in-depth knowledge about parallelism, scalability in computer architecture.

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- To study the scalability and clustering issues and the technology necessary for them.
- To understand the technologies enabling parallel computing.
- To study the different types of interconnection networks.
- To study the different parallel programming models.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Outline the terminology and concepts of parallel Architecture	K2
CO2	Understand the concepts of Parallel Programming Performance	K2
CO3	Develop the Workload driven emulation	K3
CO4	Understand the Snoop Based Multiprocessor Design	K2
CO5	Explain the concepts of Scalable Multiprocessors	K2
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M		M				M	M
CO2	M		M				M	M
CO3	M		M				M	M
CO4	M		M				M	M
CO5	M		M				M	M

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 INTRODUCTION **L-9 Hours**

Introduction to Parallel Architecture, Convergence of Parallel Architecture, Fundamental Design Issues, Parallel Application, Parallelization Process, Example Program..

UNIT 2 PARALLEL PROGRAMMING FOR PERFORMANCE **L-9 Hours**

Partitioning for Performance, Data Access and Communication in a Muti-Memory System, Orchestration for Performance, Case Studies.

UNIT 3 WORKLOAD DRIVEN EVALUATION **L-9 Hours**

Scaling Workloads and Machines, Evaluating a Real Machine, Cache Coherence, Memory Consistency, Snooping Protocols, Synchronization.

UNIT 4 SNOOP BASED MULTIPROCESSOR DESIGN **L-9 Hours**

Correctness Requirements, Base Design, Multi-Level Cache Hierarchies, Split Transaction Bus, Case Studies.

UNIT 5 SCALABLE MULTIPROCESSORS **L-9 Hours**

Scalability, Realizing Programming Models, Physical DMA, User Level Access, Dedicated Message Processing, Shared Physical Address Space, Clusters and Networks of Workstations.

Total: 45 Hours

G. Learning Resources (in IEEE Format)

i. Text Books:

1. D.E. Culler, J.P. Singh, and A. Gupta. Parallel Computer Architecture - A Hardware/Software Approach. Morgan Kaufmann Publishers, 2010.(Unit 1-5)

ii. Reference Books:

1. N.E. Jerger and Li-Shiuan Peh," On-Chip Networks" Morgan and Claypool, 2009.
2. D.J. Sorin, M.D. Hill, and D.A. Wood,"A Premier on Memory Consistency and Cache Coherence", Morgan and Claypool, 2011.
3. John P. Hayes, "Computer Architecture and Organisation" ,MCGraw Hill. 3rd Edition, 1998,
4. Hwang K. and Briggs. F.A, "Computer Architecture and Parallel Processing", MCGraw Hill, 1985.

iii. Online References:

1. Course on "Computer networks and internet Protocol",Dec 05, 2021[online] Available: https://nptel.ac.in/courses/106/104/106104024/
2. Course on "Global **network** for advanced **management**" , Dec 05, 2021[online], Available: https://globalnetwork.io/

COURSE CODE	COURSE TITLE	L	T	P	C
2161CS211	Software Engineering Principles and Practices	3	0	2	4

A. Preamble

To provide an in-depth knowledge about the Software Architecture, Software Documentation.

B. Prerequisite Courses

Software Engineering

C. Course Objectives

Students undergoing this course are expected to

- To do project management and cost estimation
- To gain knowledge of the System Analysis and Design concepts.
- To understand software testing approaches
- To be familiar with Software Engineering tools

.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Outline the basics of software engineering.	K2
CO2	Demonstrate use of software configuration and quality management.	K2
CO3	Construct various models used in software lifecycle.	K3
CO4	Understand various design and testing techniques used in software engineering.	K2
CO5	Apply various tools and techniques for software maintenance.	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M						M	
CO2		M						
CO3	H	M	M		H		M	M
CO4	M	M			H			M
CO5			H		H			

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 INTRODUCTION TO SOFTWARE ENGINEERING L-9 Hours

What Is Software Engineering, Phases in the Development of Software, Software Engineering Ethics, Planning a Software Development Project, Controlling a Software Development Project, The Waterfall Model, Agile Methods, The Rational Unified Process, Model-Driven Architecture.

UNIT 2 CONFIGURATION AND SOFTWARE QUALITY MANAGEMENT L-9 Hours

Tasks and Responsibilities, Configuration Management Plan, People Management, Team Organization, On Measures and Numbers, Taxonomy of Quality Attributes, Perspectives on Quality, The Quality System, Software Quality Assurance, Capability Maturity Model, Algorithmic Models, Guidelines for Estimating Cost, Distribution of Manpower over Time, Agile Cost Estimation, A Taxonomy of Software Development Projects, Risk Management.

UNIT 3 SOFTWARE LIFE CYCLE L-9 Hours

Requirements Elicitation, Requirements Documentation and Management, Requirements Specification Techniques, Verification and Validation, Classic Modeling Techniques, Unified Modeling Language, Software Architecture and the Software Life Cycle, Architecture Design, Architectural Views, Architectural Styles, Software Architecture Assessment.

UNIT 4 SOFTWARE DESIGN AND TESTING L-9 Hours

Design Considerations, Classical Design Methods, Object-Oriented Analysis and Design Methods, How to Select a Design Method, Design Patterns, Design Documentation, Verification and Validation, Test Objectives, Testing and the Software Life Cycle, Verification and Validation Planning and Documentation, Manual Test Techniques, Coverage-Based Test Techniques, Fault-Based Test Techniques, Error-Based Test Techniques.

UNIT 5 SOFTWARE MAINTENANCE AND TOOLS L-9 Hours

Maintenance Categories Revisited, Major Causes of Maintenance Problems, Reverse Engineering and Refactoring, Toolkits, Language-Centered Environments, Integrated Environments and Work Benches, Process-Centered Environments, User Interface Design, Human Factors in Human–Computer Interaction, Role of Models in Human–Computer Interaction, Design of Interactive Systems, Reuse Dimensions, Reuse and the Software Life Cycle, Reuse Tools and Techniques, Component-Based Development Process and Component Life Cycle, Service-Oriented Software Engineering, Challenges of Global System Development

Total: 45 Hours

G. Laboratory of Experiments — Total : 30 Hours

TASK 1	Create a hash table and perform open addressing for a set of values. **Tools: C/C++/ Java**
TASK 2	For a given graph perform graph coloring. **Tools: C/C++/ Java**
TASK 3	Create a Btree for a given set of values and perform insert and delete operations. **Tools: C/C++/ Java**
TASK 4	Perform two types of rotations in Red Black Tree. **Tools: C/C++/ Java**
TASK 5	Find out the Maximum flow and Minimum cut in a graph for any given number of nodes. **Tools: C/C++/ Java**
TASK 6	Implement string matching by Rabin-Karp Algorithm. **Tools: C/C++/ Java**
TASK 7	Implement string matching by Knuth-Morris-Pra Algorithm. **Tools: C/C++/ Java**
TASK 8	Solve TSP for a given graph. **Tools: C/C++/ Java**
TASK 9	Solve Set Cover Problem for given set of elements. **Tools: C/C++/ Java**
TASK 10	Write a program to solve subset sum. **Tools: C/C++/ Java**

Total: 75 Hours

H. Learning Resources (in IEEE Format)

i. Text Books:

1. Hans van Vliet, "Software Engineering: Principles and Practice", 3rd Edition, 2010.(Unit 1-5)

ii. Reference Books:

1. Deepak Jain, "Software Engineering-Principles and Practices", Oxford University Press, First Edition, 2018

iii. Online References:

1. Course on “Software engineering principles” Nov 29, 2021[online], Available: https://nptel.ac.in/content/storage2/courses/108105057/Pdf/Lesson-33.pdf
2. Course on “Software Development Processes and Methodologies” Dec 05, 2021[online], Available: https://www.coursera.org/learn/software-processes

COURSE CODE	COURSE TITLE	L	T	P	C
2161CS218	Advanced Computer Networks	3	0	2	4

A. Preamble

The course deals with the concepts of networking, Modeling and Simulation techniques. Also represents the working principles of wireless, mobile and satellite networks. It also covers the distributed system environment.

B. Prerequisite Courses

Computer Networks, Graph theory

C. Course Objectives

Students undergoing this course are expected to

- Be familiar with the concepts of TCP/IP reference model.
- Understand the concepts of Protocols, network interfaces.
- Performance study of Wireless networks and mobile networks.
- Identify the representation of Satellite networks.
- Understand the impact of Distributed systems.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Develop the Working concepts of TCP-IP reference model and IPV6 message format and its services.	K3
CO2	Identify the networking concepts by Simulation and Modelling.	K3
CO3	Organize the Functionalities of wireless networks and mobile network.	K3
CO4	Build the scenario for Satellite Networks.	K3
CO5	Construct the Distribution System setup and its requirements.	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M		M				M	M
CO2	M		M				M	M
CO3	M		M				M	M
CO4	M		M				M	M
CO5	M		M				M	M

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 INTRODUCTION L-9 Hours

Introduction, TCP/IP Fundamentals: TCP, UDP, IP, Performance Measurement of TCP/IP Networks: Reasons for Network Measure, Measurement Task, Classification of Measurement Tools Popular Measurement Tools and Their Applications.

UNIT 2 NETWORK SIMULATION AND MODELING L-9 Hours

The Role of Simulation, Steps of a Systematic Simulation Study, Types of Simulations, Simulation Validation and Verification, Confidence Level of Simulation Results, Simulation with Self-Similar Traffic, Classification of Simulation Tools, The ‘‘ns’’ Network, OPNET, TCP Modeling.

UNIT 3 TCP/IP PERFORMANCE OVER WIRELESS NETWORKS AND MOBILE NETWORKS L-9 Hours

Wireless Networks, TCP Performance Issues Over Wireless Links, Improving TCP Performance over Wireless Links, Wireless System Evolution and TCP/IP, Cellular and Ad Hoc Networks, TCP Performance in Cellular Networks, TCP Performance in Ad Hoc Networks.

UNIT 4 TCP/IP PERFORMANCE OVER SATELLITE NETWORKS L-9 Hours

A Brief History of Data Satellites, Motivations for Using Satellites, Types of Satellites Satellite Internet Architectures, Satellite Characteristics Affecting TCP, TCP Enhancements for Satellite Networks, Advanced Enhancements and New Versions of TCP, New Transport Protocols for Satellite Links.

UNIT 5 DISTRIBUTED SYSTEMS L-9 Hours

Distributed System, Goals, Types of Distributed Systems, System Architectures, Architectures Versus Middleware, Self-Management in Distributed Systems, Processes: Threads, Virtualization, Clients, Servers, Code Migration, Communication: Fundamentals, Remote Procedure Call, Message-Oriented Communication, Stream-Oriented Communication, Multicast Communication.

Total: 45 Hours

G. Laboratory Experiments Total : 30 Hours

TASK 1	Working with Networking Commands Tcpdump, Tcpstat, Ttcp, Netperf, NetPIPE.
TASK 2	Extract the Packet from network interface and analysis the protocol, addressing. **Tools: Wireshark, JPCAP**
TASK 3	Perform simulation for Multi-Antenna Cellular Network. **Tools: NS3**
TASK 4	Perform simulation for Heterogeneous Network.

	Tools: NS3
TASK 5	Simulate the Under-Laid Cellular Networks in-terms of packet transfer and delay. **Tools: NS3**
TASK 6	Simulate a geostationary satellite scenario with their functionalities. **Tools: NS2**
TASK 7	Simulate a Low Earth Orbit (LEO) satellites with their workings. **Tools: NS3**
TASK 8	Program to implement Chat Server. **Tools: C /Java**
TASK 9	Program to implement Remote Procedure Call. **Tools: C/Java**
TASK 10	To Simulate the Distributed Mutual exclusion. **Tools: C/Java**

Part-2

Use cases:

1.Geostationary satellite: Consider an INSAT-3A multipurpose geostationary satellite and two satellite terminals, one at Bangkok and the other at Baghdad. The position of Bangkok is 13.9-degree latitude north and 100.9-degree longitude east. The position of Baghdad is 33.8-degree latitude north and 44.4-degree longitude east. INSAT-3A is used to provide television broadcasting from Bangkok to Baghdad. INSAT-3A is positioned at 93.5 degrees longitude East. The traffic consists of a FTP source and a CBR stream. The simulation lasts for 50 secs. Analyse the trace file and find the following:

a. End-to-end delay between two terminals
b. What is the nature of the delay that you expect in this scenario.

2.Low-earth orbit: Sets up two terminals, one in Boston and one at Berkeley. Send a packet in each second from Berkeley to Boston for whole day. Consider the following parameters for Iridium constellation:
The simulation lasts for one earth rotation (86400 sec).
Analyse the trace file and find the following:
i)What should be the nature of Hop-count for the packets sent from source to destination. Plot and verify this with graph.
ii)What should be the nature of end-to-end delay for the packets sent from source to destination and how it is related with the plot of count.

3.Chat server: Chat server is a standalone application that is made up the combination of two-application, server application (which runs on server side) and client application (which runs on client side). This application is using for chatting in LAN. To start chatting you must be connected with the server after that your message can broadcast to each and every client.

a. A simple server that will accept a single client connection and display everything the client says on the screen. If the client user types "bye", the client and the server will both quit.

b. A server as before, but this time it will remain 'open' for additional connection once a client has quit. The server can handle at most one connection at a time.
c. A server as before, but this time it can handle multiple clients simultaneously. The output from all connected clients will appear on the server's screen.
d. A server as before, but this time it sends all text received from any of the connected clients to all clients. This means that the server has to receive and send, and the client has to send as well as receive.
e. Wrapping the client from step 4 into a very simple GUI interface but not changing the functionality of either server or client. The client is implemented as an Applet, but a Frame would have worked just as well (for a stand-alone program).

4.Remote procedure call: Remote Procedure Call (RPC) is an inter-process communication that allows a computer program to cause a subroutine or procedure to execute in another address space (commonly on another computer on a shared network) without the programmer explicitly coding the details for this remote interaction.

a. The client calls the client stub. The call is a local procedure call, with parameters pushed onto the stack in the normal way
b. The client stub packs the parameters into a message and makes a system call to send the message. Packing the parameters is called marshalling.
c. The kernel sends the message from the client machine to the server machine.
d. The kernel on the server machine passes the incoming packets to the server stub.
e. Finally, the server stub calls the server procedure. The reply traces the same steps in the reverse direction

5. Distributed Mutual Exclusion:

Concurrent access of processes to a shared resource or data is executed in mutually exclusive manner. Only one process is allowed to execute the critical section (CS) at any given time. In a distributed system, shared variables (semaphores) or a local kernel cannot be used to implement mutual exclusion. Message passing is the sole means for implementing distributed mutual exclusion.

Process1: Request resource:
Resource Allocated ◊ No more requests process for this resource.
Process2: RequestResource◊Denied
Process1:ExitResource:
Process2: Request Resource◊ Allocated
Press a key (except q) to enter a process into critical section. Press q at any time to exit.
Process0enteredcriticalsection.
Error: Another process is currently executing critical section. Please wait till its execution is over. Process0 exits critical section.

Process1entered critical section.

Process1 exits critical section.

Process 2 entered critical section.

Error: Another process is currently executing critical section. Please wait till its execution is over.
Process 2 exits critical section.

Total: 75 Hours

H. Learning Resources (in IEEE Format)

i. Text Books:

1. High Performance TCP/IP: Networking Concepts, Issues, and Solutions, Mahbub Hassan and Raj Jain, IST Edition, 2009. (Unit 1-4).
2. Distributed Systems, Maarten Van Steen and Andrew S.Tanenbaum, Third Edition, Pearson Publication,2017.(Unit 5)

ii. Reference Books:

1. TCP/IP Illustrated (Volume I, Volume II and Volume III), W. Richard Stevens, Addison-Wesley.

iii. Online References:

1. TCP/IP Fundamentals, https://www.thegeekstuff.com/2011/11/tcp-ip-fundamentals/
2. NetworkModellingandSimulations,https://www.researchgate.net/publication/220674719_Network_modelling_and_simulation_tools
3. TCP/IPPerformanceoverwirelessnetworks,https://dl.acm.org/doi/10.1145/215530.21554
4. TCP/IPPerformanceoverSatelliteCommunications,https://sites.cs.ucsb.edu/~ebeldin g/courses/284/s06/papers/Satellite_TCP.pdf
5. Distributed systems, https://blog.stackpCath.com/distributed-system/

COURSE CODE	COURSE TITLE	L	T	P	C
2161CS129	Machine Learning Techniques	3	0	0	3

A. Preamble

To provide an in-depth knowledge in Machine Learning techniques..

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- To introduce students to the basic concepts and techniques of Machine Learning.
- To have a thorough understanding of the Supervised and Unsupervised learning
- techniques
- To study the various probability based learning techniques
- To understand graphical models of machine learning tools

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Understand the basic Concepts of Machine Learning	K2
CO2	Outline about the Supervised Machine Learning	K2
CO3	Illustrate the concepts Unsupervised Machine Learning	K2
CO4	Interpret various Probabilistic Models used in Machine Learning	K2
CO5	Apply various Tools used in Machine Learning	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M							
CO2	M				M		M	
CO3	M				M		M	
CO4	M				H		M	
CO5	M		M	H	H	M	H	

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 INTRODUCTION L-9 Hours

Machine Learning - Machine Learning Foundations - Types of Machine Learning – Design of a Learning system – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm.

UNIT 2 SUPERVISED LEARNING L-9 Hours

Regression-Linear Regression- Classification - Naïve Bayes - Discriminant Functions - Probabilistic Generative Models -Probabilistic Discriminative Models-Decision Trees – Pruning -Neural Networks -Feed-forward Network Functions - Back propagation- Support vector machines - Ensemble methods- Bagging- Boosting.

UNIT 3 UNSUPERVISED LEARNING L-9 Hours

Clustering- K-means - EM Algorithm -The Curse of Dimensionality - Dimensionality Reduction - Factor analysis – Linear Discriminant analysis-Principal Component Analysis - Probabilistic PCA

UNIT 4 PROBABILISTIC GRAPHICAL MODELS L-9 Hours

Graphical Models - Undirected graphical models - Markov Random Fields - Directed Grap hical Models -Bayesian Networks - Conditional independence properties - Inference – Learning Generalization - Hidden Markov Models.

UNIT 5 MACHINE LEARNING TOOLS L-9 Hours

Machine Learning using Weka - Python for Machine Learning –Machine Learning using R- Introduction to Mahout

Total: 45 Hours

G. Learning Resources (in IEEE Format)

i. Text Books:

1. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
2. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data First Edition, Cambridge University Press, 2012.

ii. Reference Books:

1. Ethem Alpaydin, Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press, 2014.
2. Jason Bell, Machine learning ,Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014.
3. Stephen Marsland, Machine Learning – An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

iii. Online References:

1. Course on “Software engineering principles”, Dec 05, 2021[online], Available : https://nptel.ac.in/content/storage2/courses/108105057/Pdf/Lesson-33.pdf
2. Course on “Software Development Processes and Methodologies” Dec 22, 2021[online], Available: https://www.coursera.org/learn/software-processes

COURSE CODE	COURSE TITLE	L	T	P	C
2161CS304	MACHINE LEARNING TECHNIQUES LABORATORY	0	0	2	1

A. Preamble

To understand the Image Processing technology and tool kits for programming.

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- Understand the implementation procedures for the machine learning algorithms.
- Design Java/Python programs for various Learning algorithms.
- Apply appropriate data sets to the Machine Learning algorithms.
- Identify and apply Machine Learning algorithms to solve real world problems.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Apply the programming concepts of lemmatization, tokenization	K3
CO2	Implement the classification Process	K3
CO3	Execute concepts of clustering Process	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1		**M**		**H**			M	
CO2	**M**	**M**		**H**	**M**		M	
CO3	**M**	**M**		**H**	**M**		M	

H- Strong; M-Medium; L-Low

F. Laboratory Experiments

Total : 30 Hours

TASK 1	Perform a stop word removal a text file and print the text **Tools: R/ Python / Weka**
TASK 2	Implement lemmatization, tokenization using NLTK tool kit in python using any text file **Tools: R/ Python / Weka**
TASK 3	Perform a classification using naïve bayes in Mahout **Tools: R/ Python / Weka**
TASK 4	Perform a classification using Support vector machine **Tools: R/ Python / Weka**

TASK 5	Implement k-means clustering algorithm **Tools: R/ Python / Weka**
TASK 6	Implement a decision tree and KNN for any dataset and compare the accuracy **Tools: R/ Python / Weka**
TASK 7	Illustrate PCA **Tools: R/ Python / Weka**

Total: 30 Hours

COURSE CODE	COURSE TITLE	L	T	P	C

2161CS141	Network Management	3	0	0	3

A. Preamble

The Course Introduces the Advance Concepts of SNMP Network Management, Network Management Access, Security Management, Configuration Management, Fault Management in Network

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- To understand the need for interoperable network management as a typical distributed application
- To familiarize concepts and terminology associated with SNMP
- To be aware of current trends in network management technologies
- To implement and experiment the routine management tasks using network management tools

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Analyze the issues and challenges pertaining to management of emerging network technologies such as wired/wireless networks and high-speed internets	K2
CO2	Apply network management standards to manage practical networks	K3
CO3	Understand SNMP for managing the network	K2
CO4	Articulate network management tools to manage the network by performing routine maintenance tasks	K3
CO5	Formulate the scheme for managing various components of network in different application.	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M		M	M			H	H
CO2							H	
CO3					H			H
CO4			H				H	M
CO5	H			H			H	M

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 OVERVIEW ABOUT NETWORK MANAGEMENT L-9 Hours

Analogy of Telephone Network Management, Data and Telecommunication Network Distributed computing Environments, TCP/IPBased Networks: The Internet and Intranets, Communications Protocols and Standards- Communication Architectures, Protocol Layers and Services; Case Histories of Networking and Management – The Importance of topology , Filtering Does Not Reduce Load on Node, Some Common Network Problems; Challenges of Information Technology Managers, Network Management: Goals, Organization, and Functions.

UNIT 2 NETWORK MANAGEMENT FOUNDATIONS L-9 Hours

Standards, Models, and Language: Network Management Standards, Network Management Model, Organization Model, Information Model – Management Information Trees, Managed Object Perspectives, Communication Model; ASN.1- Terminology, Symbols, and Conventions, Objects and Data Types, Object Names, An Example of ASN.1 from ISO 8824; Encoding Structure; Macros, Functional Model.

UNIT 3 SNMP NETWORK MANAGEMENT L-9 Hours

SNMPv2 - Major Changes in SNMPv2 - SNMPv2 System Architecture - SNMPv2 Structure of Management Information - The SNMPv2 Management Information Base - SNMPv2 Protocol - Compatibility withSNMPv1 - Configuration management - Fault management - Performance management - Event Correlation Techniques 168 security management – Accounting management - Report Management - Policy Based Management – Services Level Management.

UNIT 4 NETWORK MANAGEMENT ACCESS L-9 Hours

Network Management Tools - Network Statistics Measurement Systems - History of Enterprise Management - Commercial Network management- Systems - System Management and Enterprise Management Solutions. Network Management Applications:, Inventory Management, Network Topology, Fault Management- Fault Detection, Fault Location and Isolation Techniques, Performance Management – Performance Metrics, Data Monitoring, Problem Isolation, Performance Statistics; Security Management.

UNIT 5 NETWORK MANAGEMENT APPLICATIONS L-9 Hours

Security Management – Policies and Procedures, Security Breaches and the Resources Needed to Prevent Them, Firewalls, Cryptography, Authentication and Authorization, Client/Server Authentication Systems, Messages Transfer Security, Protection of Networks from Virus Attacks. Configuration Management- Network Provisioning, Inventory Management, Network Topology.

Total: 45 Hours

G. Learning Resources (in IEEE Format)

i. Text Books:

1. Mani Subramanian, "Network Management - Principles and Practice", Pearson Education, second edition ,2010'.
2. Lakshmi G Raman, "Fundamentals of Telecommunication Network Management", Eastern Economy Edition IEEE Press, New Delhi, 1999.

ii. Reference Books:

1. Stephen Morris, "Network Management, MIBs and MPLS - Principles, Design and Implementation", Pearson Education, 2003.
2. Marks Burges, "Principles of network system administration",Wiley,2000

iii. Online References:

1. Lecture Notes on "Communication and Functional Models", Dec 22,2021[online], Available: http://ycchen.im.ncnu.edu.tw/nm/ch_5x.ppt
2. Course on "**Demystifying Networking"** JAn 05,2022[online], Available: https://www.rivier.edu/faculty/vriabov/NWM_ch_14.ppt%20169

PROGRAM SPECIFIC ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	C
2162CS159	EVOLUTIONARY COMPUTING TECHNIQUES	3	0	2	4

A. Preamble

To provide an in-depth knowledge in issues involved in mobile communication system design and analysis.

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- Formulate a problem as an evolutionary computation search/optimization by specifying representations, selection and variation operators.
- Understand the concept of genetic algorithm
- Conduct evolutionary optimization experiments and properly report and discuss the results.
- Interpret the critique evolutionary computation articles.
- Understand the Artificial Bee colony optimization.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Understand the issues involved in Simulated Annealing	K2
CO2	Explain the concept of Genetic algorithm.	K2
CO3	Outline the basics of ant colony optimization.	K2
CO4	Interpret the knowledge in different particle swarm optimization system.	K2
CO5	Illustrate the fundamentals of Artificial Bee colony Optimization.	K2
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	H			H	H	M	H	
CO2	H			H	H	M	M	
CO3	H	M		H	H	M		M
CO4	H		M	M		H	H	M
CO5	H			H	H	M	H	

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 SIMULATED ANNEALING — L-11 Hours

Historical development-Features-Classification and Components – Advantage – applications- Annealing schedule – Parameter selection – Application- Hill climbing: Mathematical Description-Local and Global Maxima-Ridges-Plateau-Applications

UNIT 2 GENETIC ALGORITHM — L-9 Hours

Biological background – Schema theorem – GA Operators: Cross over, Mutation and its types- GA Algorithm- Variations of GA: Adaptive GA and Real coded GA

UNIT 3 ANT COLONY OPTIMIZATION — L-8 Hours

Ant foraging behavior – Theoretical considerations – Convergence proofs-ACO Algorithm-ACO and model based search – variations of ACO : Elitist Ant System(EAS), MinMax Ant System(MMAS) and Rank based Ant Colony System(RANKAS).

UNIT 4 PARTICLE SWARM OPTIMIZATION — L-7 Hours

Principle of bird flocking and fish schooling –evolution of PSO –Operating Principles-PSO Algorithm-Neighborhood topologies –Convergence criteria – Variations of PSO : Binary , weighed , repulsive , combined effect PSO and clonal PSO.

UNIT 5 ARTIFICIAL BEE COLONY(ABC) OPTIMIZATION — L-10 Hours

Behavior of real bees, ABC algorithm- variations of ABC :ABCgbest and ABCgbestdist. Case Study: Travelling Salesman Problem, knapsack Problem , N Queens Problem and Graph Coloring

Total: 45 Hours

G. Laboratory Experiments — Total : 30 Hours

TASK 1	Develop an optimal solution for the team management with various marketing domains using Hill Climbing algorithm. **Tools: C/C++/Java**
TASK 2	Develop a search space and objective function using Genetic Algorithm. **Tools: C/C++/Java**
TASK 3	Develop a multiple optimal solution using Genetic Algorithm. **Tools: C/C++/Java**
TASK 4	Construct the optimal route/ Shortest path using Ant colony optimization technique. **Tools: C/C++/Java**
TASK 5	Develop a Tic-Tac-Toe simulation model using Minmax Ant system. **Tools: C/C++/Java**
TASK 6	Develop an approximate solution using Ant colony Optimization algorithm.

	Tools: C/C++/Java
TASK 7	Improve a candidate solution iteratively using particle swarm optimization algorithm. **Tools: C/C++/Java**
TASK 8	Optimize the numerical problem using Artificial bee colony(abc) optimization algorithm. **Tools: C/C++/Java**

Part-2

Use Cases:

1. Analyze the Sales Marketing /Financial Marketing
2. Engineering Design- Computer Modeling and Simulation
3. Optimal Solution in Traffic and Shipman routing
4. Decision making by Learning Robots
5. Vehicle routing problem with pick-up and delivery
6. Permutation flow shop problem
7. Frequency Assignment problem
8. Stochastic Vehicle Routing Problem
9. Group shop Scheduling problem

Total: 75 Hours

H. Learning Resources (in IEEE Format)

i. Text Books:

1. David E Goldberg, "Genetic Algorithms in search, Optimization and machine learning", 1stEdition , Pearson, 2002.
2. Kenneth A DeJong, "Evolutionary Computation A Unified Approach", Prentice Hall of India, New Delhi, 2006.

ii. Reference Books:

1. Elaine Rich, Kevin Knight, " Artificial Intelligence", Tata McGraw Hill, 2011.
2. Marco Dorigo and Thomas Stutzle, "Ant Colony optimization", Prentice Hall of India, New Delhi 2005.

iii. Online References:

1. Course on "Evolutionary computation for single And multi-objective optimization" Dec 22,2021 [online], Available : https://nptel.ac.in/courses/112/103/112103301/
2. Course on "Evolutionary Computing. Techniques: Genetic. Algorithms" Dec 22,2021 [online], Available: https://www.iitk.ac.in/eeold/archive/courses/2013/intel-info/d2pdf2.pdf

COURSE CODE	COURSE TITLE	L	T	P	C
2162CS117	Cryptography & Network Security	3	0	0	3

A. Preamble

To provide a thorough knowledge about the cryptography and network security

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- Understand the fundamental principles of access control models and techniques, authentication and secure system design.
- Have a strong understanding of different cryptographic protocols and techniques
- and be able to use them.
- Apply methods for authentication, access control, intrusion detection and
- prevention.
- Identify and mitigate software security vulnerabilities in existing systems.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Understand the basic concepts of Encryption	K2
CO2	Outline the Number theory and public key cryptography.	K2
CO3	Explain concepts of Message authentication and Hash functions.	K2
CO4	Apply the concepts of digital signature and authentication protocols.	K3
CO5	Implementation of Network security	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	H		M	M			M	
CO2	M		M				M	
CO3	M		M				M	
CO4	M				H		H	H
CO5	M				H		H	H

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 CONVENTIONAL ENCYRPTION **L-9 Hours**

Introduction to security attacks (DDoS) - services and mechanism - Conventional encryption model - DES - RC 5 Introduction to AE 5 - Random number generation.

UNIT 2 NUMBER THEORY AND PUBLIC KEY CRYPTOGRAHY **L-9 Hours**

Modular arithmetic - Euler's theorem - Euclid's algorithm - Chinese remainder theorem - Primary and factorization - Discrete logarithms - RSA algorithm - Diffe Hellmann key exchange.

UNIT 3 MESSAGE AUTHORISATION AND HASH FUNCTIONS **L-9 Hours**

Hash functions - Authentication requirements - authentication function - Message Authentication codes - Secure Hash Algorithms

UNIT 4 DIGITAL SIGNATURE AND AUTHENTICATION PROTOCOLS **L-9 Hours**

Digital Signature - Authentication protocols - Digital Signature standard.

UNIT 5 NETWORK SECURITY **L-9 Hours**

Pretty good privacy - S/MIME-IP Security Overview - Web Security.

Total: 45 Hours

G. Learning Resources (in IEEE Format)

i. Text Books:

1. Stallings W., "Cryptography and Network Security Principles and Practice", Prentice Hall, New Jersey, 1999.(Unit 1 - 5)

ii. Reference Books:

1. Biham and A. Shamir, "Diffential Crypt analysis of the data encryption standard", Springer Verlag, 1993.
2. D.Denning, "Cryptography and data security", Addison Wesley, 1982.
3. N.Kobliz, "A course on Number theory and Cryptography", Springer Verlag, 1994.

iii. Online References:

1. Course on “Cryptography and network security” Dec 22,2021[online], Available: https://nptel.ac.in/courses/106/105/106105162/
2. Course on “Cryptography and network security” Dec 24,2021 [online],Available: https://www.coursera.org/lecture/managing-network-cybersecurity/cryptography-and-network-security-w9SuJ

COURSE CODE	COURSE TITLE	L	T	P	C
2162CS116	MOBILE AND PERVASIVE COMPUTING	3	0	0	3

A. Preamble

To provide a thorough knowledge about Wireless Networks, Mobile Computing and Pervasive Computing.

B. Prerequisite Courses

Mobile Computing

C. Course Objectives

Students undergoing this course are expected to

- Understand the fundamental principles of wireless networks.
- Understand the Mobile computing environment and different security protocols
- Explain the different tracking management schemes and Pervasive computing concepts.

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Understand the fundamentals of Wireless Networks and Mobile Computing.	K2
CO2	Discuss the basics of Mobile computing environment and security.	K2
CO3	Outline the concepts of tracking management schemes wireless mobile networks.	K2
CO4	Interpret the concepts of Pervasive Computing.	K2
CO5	Explain the open protocols and context aware sensor networks.	K2
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	H		M	H	M	M	M	H
CO2	M		M				M	
CO3	M		M			H	M	
CO4	M				H		H	H
CO5	M			H	H	H	H	H

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 EMERGING TECHNOLOGIES L-9 Hours

Introduction to Metadata, Categorizing Metadata, Metadata management in practice, Tools for Metadata management Wireless networks- Emerging technologies - Blue tooth, WiFi, WiMAX, 3G ,WATM.-Mobile IP protocols –WAP push architecture-Wml scripts and applications..

UNIT 2 MOBILE COMPUTING ENVIRONMENT AND SECURITY L-9 Hours

Mobile computing environment – Functions -Architecture-Design considerations - content architecture -CC/PP exchange protocol -context manager - Data management in WAE-Coda file system- Caching schemes- Mobility QOS - Security in mobile computing.

UNIT 3 HANDOFF AND TRACKING MANAGEMENT SCHEMES L-9 Hours

Handoff in wireless mobile networks-Reference model-Handoff schemes- Location management in cellular networks - Mobility models- Location and tracking management schemes- Time, movement, profile and distance based update strategies - ALI technologies

UNIT 4 PERVASIVE COMPUTING L-9 Hours

Pervasive Computing- Principles, Characteristics- Interaction transparency - Context aware - Automated experience capture. Architecture for pervasive computing- Pervasive devices - Embedded controls.- Smart sensors and actuators -Context communication and access services

UNIT 5 OPEN PROTOCOLS AND CONTEXT AWARE SENSOR NETWORKS L-9 Hours

Open protocols- Service discovery technologies- SDP, Jini, SLP, UpnP protocols–data synchronization- SyncML framework - Context aware mobile services -Context aware sensor networks - Addressing and communications – Context aware security.

Total: 45 Hours

G. Learning Resources (in IEEE Format)

i. Text Books:

1. Ivan Stojmenovic , “Handbook of Wireless Networks and Mobile Computing”, John Wiley & sons Inc, Canada, 2002

ii. Reference Books:

1. Asoke K Taukder,Roopa R Yavagal,”Mobile Computing”, Tata McGraw Hill Pub Co. , New Delhi, 2005.
2. Seng Loke,” Context-Aware Computing Pervasive Systems” Auerbach Pub., New York, 2007.

iii. Online References:

1. Lecture Notes on “Mobile computing” ,Dec 22,2021[online], Available: https://caribbeanclimatehub.org/wp-content/uploads/formidable/17/mobile-computing-lecture-notes-nptel.pdf

COURSE CODE	COURSE TITLE	L	T	P	C
2162CS212	Software Defined Networks	2	0	2	3

A. Preamble

This course introduces software defined networking, that allows a logically centralized software program to control the behavior of an entire network.

B. Prerequisite Courses

Computer Networks

C. Course Objectives

Students undergoing this course are expected to

- Differentiate between traditional networks and software defined networks
- Understand advanced and emerging networking technologies
- Obtain skills to do advanced networking research and programming

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Compare SDN to traditional networks to examine the challenges and opportunities associated with SDN.	K2
CO2	Understand the functions and components of the SDN architecture.	K2
CO3	Construct a SDN network consisting of SDN switches and a centralized controller.	K3
CO4	Apply software programs to perform varying and complex networking tasks.	K3
CO5	Develop the emerging SDN applications.	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	H		H	H	M	H	M	M
CO2	H		H	M	M	M	H	H
CO3	H		H	H	H	H	H	H
CO4	M		H	H	H	M	H	M
CO5	M		M	M	H	M	M	M

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 Introduction to SDN — L-6 Hours

Introduction; SDN Origin and evolution - The Genesis of SDN: Forerunners of SDN, Birth of SDN, Sustaining Interoperability, Open Source contributions, Legacy Mechanisms towards SDN; Characteristics of SDN; Advantages of SDN; Opportunities and Challenges

UNIT 2 SDN Architecture — L-6 Hours

SDN Architecture. Centralized and Distributed Control and Data planes. Open Network Operating Systems (ONOS). Northbound and Southbound interfacing, Open Flow.

UNIT 3 Design and Development of SDN — L-6 Hours

Languages and functions available for programming SDNs, northbound API. Mininet: Switch implementations - Open vSwitch, Controller implementations - POX, Floodlight. Special Purpose controllers - Flowvisor, RouteFlow.

UNIT 4 SDN Programming and Security — L-6 Hours

Network Programmability - Network Function Virtualization (NFV) - NFV Benefits and Requirements - NetApp Development, Network Slicing. Security Analysis and potential attacks in SDN, Solutions to security issues in SDN.

UNIT 5 SDN Applications and Use Cases — L-6 Hours

Network Virtualization, Network Topology and Topological Information Abstraction. Data Centers, Home Networks, Traffic Engineering, Network Telemetry.

Total: 30 Hours

G. Laboratory Experiments — Total : 30 Hours

TASK 1	Introducing Mininet and setting up environment • Download Mininet VM (Virtual Machine), run VM on the virtual box, SSH into VM **Tools: Mininet**
TASK 2	Network Topology creation and REST API introduction. • Building a mininet virtual LAB network, Checking your HP SDN VAN controller running your LAB, Introduction to the REST API, Getting list of switches, list of end-nodes and flow tables via REST API **Tools: Mininet**
TASK 3	Influencing flows via cURL commands. • cURL command line tool to authenticate to the REST API and receive a token, Retrieving some basic information via cURL (nodes/devices/flows), Pushing first flow with cURL, Redirecting the flow end to end, Explicit removal of the flows you just done **Tools: Mininet**

TASK 4	Create a network and run a simple performance test. • Single Switch Topology class that adds a single switch and n hosts into a network. Each link connected from host to switch can be set the bandwidth, delay time, and loss rate. Then create a network that contains one switch and 4 hosts. Finally, use iperf to test the bandwidth between host 1 and host 4. **Tools: Mininet**
TASK 5	Use "ovs-vsctl" command to directly control open vswitch. • Create one switch and two hosts. When there is traffic coming in port 1, forward it to port 2 and vice versa. • Two switches and two hosts. Host 0 is connected to Switch 0 while Host 1 is connected to Switch 1. And switch 0 and switch 1 are connected **Tools: Mininet**
TASK 6	Creating custom topology in POX • SSH into Virtual Machine, run the POX controller, setup a topology that connects to the controller (Create a topology with one switch connected to two hosts) **Tools: Mininet**
TASK 7	Creating custom topology in Floodlight • SSH into Virtual Machine, run the Floodlight controller, setup a topology that connects to the controller (Create a topology with one switch connected to two hosts) **Tools: Mininet**
TASK 8	Create a Router in Mininet • Three different subnets in one open vswitch, different hosts in different subnets talk to each other, add one router in the environment **Tools: Mininet**
TASK 9	Dynamically change the network parameters—link delay analysis. • Create a network from scratch using Open vSwitch, Creating links, Configuring hosts, Starting network using Open vSwitch **Tools: Mininet**
TASK 10	Dynamically change the forwarding rules. • The routing rule for the h1 to h4 is via s1-s2-s5. After 1 second, the rule is changed to via s1-s3-s5. 1 second later, the rule is changed to via s1-s4-5. Then back to via s1-s2-s5. **Tools: Mininet**

Total: 60 Hours

H. Learning Resources (in IEEE Format)

i. Text Books:

1. SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013.
2. Software-Defined Networks: A Systems Approach. United States: Systems Approach, LLC. Peterson, L., Cascone, C., Davie, B., 2021.

ii. Reference Books:

1. Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014.
2. William Stallings, “Foundations of Modern Networking”, Pearson Ltd.,2016.
3. Siamak Azodolmolky, “Software Defined Networking with OpenFlow”, Packt Publishing, 2013.

iii. Online References:

1. Software Defined Networking, The University of Chicago, Accessed on Dec 24, 2021. https://www.coursera.org/learn/sdn
2. D. Kreutz, F. M. V. Ramos, P. E. Veríssimo, C. E. Rothenberg, S. Azodolmolky and S. Uhlig, "Software-Defined Networking: A Comprehensive Survey," in Proceedings of the IEEE, vol. 103, no. 1, pp. 14-76, Jan. 2015, doi: 10.1109/JPROC.2014.2371999.

COURSE CODE	COURSE TITLE	L	T	P	C
2162CS213	Network Programming	2	0	2	3

A. Preamble

The course introduces the concepts of network programming, modeling file handling utilities, managing files and directories, Inter process communication, Socket system calls, and secure network programming in python.

B. Prerequisite Courses

C. Course Objectives

Students undergoing this course are expected to

- Understand the concept of various Linux utilities for file handling and text processing
- Familiar with kernel support functions for files and directory management
- Understand the functionality of Inter Process Communication which enables processes to communicate across a Computer Network
- Understand socket programming in Python

D. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Design file and Directory management system for the required domain and analyze the need of various kernel support functions	K3
CO2	Demonstrate the concept of Inter Process Communication and apply the various semaphore functions between the processes	K2
CO3	Apply socket programming for various applications work on client/server paradigm	K3
CO4	Illustrate various application and transport layer protocols, viz., HTTP, SMTP and TLS.	K3
CO5	Develop procedures for secured communication by analyzing the network packets	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M		M	M	M	H	M	
CO2	M		M	M	H	H	H	M
CO3	H			H	H	H	H	M
CO4	M			M	M		H	M
CO5	M			H	M	H		H

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 LINUX UTILITIES FOR FILES AND DIRECTORY MANAGEMNET

L-6 Hours

File handling utilities, process utilities, disk utilities, networking utilities, filters, text processing utilities and backup utilities. Introduction-shell as a programming language, shell script examples, file concept-file types, file system structure, kernel support for files, file status information-stat family, file and record locking-lockf and fcntl functions, file permissions- chmod fchmod,\ file ownership-chown, lchown , fchown, links-soft links and hard links – symlink, link, unlink. File and Directory management – directory contents, scanning directories- directory file APIs .

UNIT 2 INTER PROCESS COMMUNICATION L-6 Hours

Process- Process concept, kernel support for process, process attributes, process control – process creation, replacing a process image, waiting for a process, process termination, zombie process, orphan process. IPC over a network, creation, IPC between related processes using unnamed pipes, FIFOs-creation, IPC between unrelated processes using FIFOs (Named pipes), differences between unnamed and named pipes, popen and pclose library functions, Introduction to message queues, semaphores and shared memory

UNIT 3 SOCKET PROGRAMMING L-6 Hours

Introduction to sockets, socket address structures, client-server model, address formats (Linux domain and Internet domain), Socket system calls for connection oriented – communication, socket system calls for connectionless-communication, example-Client/Server Programs- Single Server-Client connection, Multiple simultaneous clients, Socket options – setsockopt, getsockopt, fcntl, TCP sockets, UDP sockets, Socket multiplexing.

UNIT 4 PROGRAMMING WITH PROTOCOLS L-6 Hours

HTTP-Downloading data from an HTTP server, Serving HTTP requests, Sending web requests through a proxy server, HTTP server, fail-over http client, FTP-Listing the files in a remote FTP server, Uploading a local file to a remote FTP server, Emailing the current working directory as a compressed ZIP file, SMTP-Finding the mail server from an email address, Writing a simple SMTP server, Writing a secure SMTP client using TLS, Writing an email client with POP3

UNIT 5 NETWORK PROGRAMMING FOR SECURITY L-6 Hours

BGP security, IPSec – Introduction, Tunnel and Transfer Modes, IPSec Authentication Header, Encapsulating Security Header and Payload, IPSec Key Exchange and VPNs. Sniffing packets, Saving packets using pcap dumper, Adding an extra header in HTTP packets, Scanning the ports of a remote host, Customizing the IP address of a packet, Replaying traffic by reading from a saved pcap file, Scanning the broadcast of packets

Total: 30 Hours

G. Laboratory Experiments — Total : 30 Hours

TASK 1	a) To implement a shell script that receives any number of file names as arguments checks if every argument supplied is a file or a directory and reports accordingly. Whenever the argument is a file, the number of lines on it is also reported. b) To illustrate a scenario where process forks to a child, and creates a child process by using forks and suddenly terminates itself. **OS: LINUX**
TASK 2	a) To implement a shell script that displays a list of all the files in the current directory to which the user has read, write and execute permissions. b) To implement the programs working with different file status information, file locking and setting file permissions. **c)** To Illustrate a program which redirects the standard input (stdin) and the standard output (stdout) of a process, so that scanf () reads from the pipe and printf () writes into the pipe. **OS: LINUX**
TASK 3	To implement a program that creates a shared memory segment of 2048 bytes and writes some text into it. Then create a child process which then reads the content written by the parent process in the shared memory segment **OS: LINUX**
TASK 4	To implement a program that creates IPC between two processes P1 and P2. P1 takes a string and passes it to P2. P2 concatenates the received string with another string without using string function and sends it back to P1 for printing. **OS: LINUX**
TASK 5	To implement the advanced socket programming scenarios: a) Handling socket errors gracefully b) Modifying a socket's send/receive buffer sizes c) Changing a socket to the blocking/nonblocking mode d) Reusing socket addresses **IDE: Anaconda with spyder notebook**
TASK 6	To implement a program for multiplexing a web server **IDE: Anaconda with spyder notebook**
TASK 7	a) Downloading data from an HTTP server b) Serving HTTP requests **c)** Extracting cookie information after visiting a website **IDE: Anaconda with spyder notebook**
TASK 8	a) Listing the files in a remote FTP server b) Uploading a local file to a remote FTP server

	c) Downloading your Google email with POP3 **IDE: Anaconda with spyder notebook**
TASK 9	Benchmarking BGP implementations with bgperf **IDE: Anaconda with spyder notebook**
TASK 10	a) Sniffing packets on your network b) Saving packets in the pcap format using the pcap dumper **IDE: Anaconda with spyder notebook**

Total: 60 Hours

H. Learning Resources (in IEEE Format)

i. Text Books:

1. W.R.Stevens, Bill Fenner, A.M.Rudoff, "Unix Network Programming", Addison wesley, Inc, 3rd Edition, 2003. (Unit 1-2)
2. Pradeeban Kathiravelu, Dr. M. O. Faruque Sarkar, "Python Network Programming Cookbook", Second Edition, Packt Publishing Ltd., 2017. (Unit 3-5)

ii. Reference Books:

1. Unix shell Programming, S.G.Kochan and P.Wood, 3rd edition, Pearson Education.
2. Linux System Programming, Robert Love, O'Reilly, SPD.Julia and David Robinson- "Text Mining with R" -O'Reilly Media Inc.,2017.

iii. Online References:

1. Beej's Guide to "Network Programming Using Internet Sockets" ,Dec 22,2021 [Online], Available : https://beej.us/guide/bgnet/pdf/bgnet_a4_c_1.pdf
2. Lecture Notes on "Network Programming: Principles and Methodologies ", Dec 25,2021[online] , Available: https://www.cs.usfca.edu/~parrt/doc/java/Sockets-notes.pdf

COURSE CODE	COURSE TITLE	L	T	P	C
2162CS214	Network Administration and Security	2	0	2	3

A. Preamble

The course introduces the roles of computer networks, network administration and security process. Network configuration, troubleshooting and mail services are discussed in this course. Intrusion detection process is used to identify the network behavior and to provide the solutions when something does not going right.

B. Prerequisite Courses

Computer Networks and UNIX Operating System

C. Course Objectives

Students undergoing this course are expected to

- Be familiar with the concepts of configure- manage and troubleshoot the network infrastructure.
- To get knowledge on plan, create and implement computer network systems
- Be able to appear any network course certification examination
- Develop skills to implement IT system and data security policies

D. Course Outcomes

Upon the successful completion of the course- students will be able to:

CO No's	Course Outcomes	K - Level
CO1	Explore the basics of Network Administration and Network Design	K3
CO2	Identify the details of Configuration and Troubleshooting	K3
CO3	Model the concepts of Networking Services and Mail Functions	K3
CO4	Build Network Security and identify the Threats	K3
CO5	Apply Intrusion Detection techniques and find the vulnerabilities	K3
Knowledge Level (Based on revised Bloom's Taxonomy) K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create		

E. Correlation of COs with Program outcomes and Programme Specific Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	M			M			H	M
CO2	M			M	H	M	H	H
CO3			M				H	M
CO4	M			M			H	H
CO5	H			H	H	M	H	M

H- Strong; M-Medium; L-Low

F. Course Contents

UNIT 1 OVERVIEW OF NETWORK ADMINISTRATION L-6 Hours

Responsibilities of the Network Administrator - Definition and Characteristics of Network - OSI Model – Comparison of OSI and TCP/IP Model - Data Encapsulation and - Planning Your Network: Designing the Network - Setting Up an IP Addressing Scheme - Naming Entities on Your Network - Registering Your Network - Adding Routers – Network Services.

UNIT 2 NETWORK CONFIGURATION& TROUBLESHOOTING L-6 Hours

Configuring TCP/IP on the Network - Configure TCP/IP - Host Configuration Modes - TCP/IP Configuration Files - Network Databases and File - Network Configuration Procedures - Configuring Routers: Routing Protocols - Configuring Routers - Troubleshooting TCP/IP: General Troubleshooting Methods - Running Software Checks - Logging Network Problems - Displaying Packet Contents – Routing Configuration - DNS Configuration.

UNIT 3 NETWORK SERVICES L-6 Hours

Names and Addresses – Host Table – Mail Services – File and Print Servers – Configuration Servers –Planning Naming Services – Other Services – Local Network Services: Network File System – Network Information Services – DHCP – Managing Distributed Servers – Post Office Servers –Mail Function.

UNIT 4 NETWORK SECURITY L-6 Hours

Security Planning – User Authentication – Application Security – Security Monitoring – Access Control – Encryption and Decryption – Firewalls – Web Server Security – Overview of Security Standards – Policies and Auditing – Overview of Security Threats: : Denial of Service - Distributed DoS - Authentication Issues - Viruses -Vulnerabilities - Malicious Users - Phishing - Forensics - Patches - Driver Updates - Configuration Backups.

UNIT 5 VULNERABILITY ANALYSIS & INTRUSION DETECTION L-6 Hours

Introduction - Penetration Studies - Vulnerability Classification – Frameworks – Malicious Logic: Computer Viruses - Computer Worms - Other Forms of Malicious Logic – Defenses -Intrusion Detection: Principles - Basic Intrusion Detection – Models – Architecture - Organization of Intrusion Detection Systems - Intrusion Response.

Total: 30 Hours

G. Laboratory Experiments — Total : 30 Hours

TASK 1	i. To create a local user account(s), group users and providing access privileges in Window/ Linux Systems. ii. To Connect computer in Local Area Network **Tool: Packet Tracer**
TASK 2	IP Addressing and Subnetting. **Tool: Packet Tracer**
TASK 3	To perform the following configurations: i. TCP/ IP ii. Domain Name System (DNS) iii. Router (Perform by using commands/ other options) **Tool: Packet Tracer**
TASK 4	To configure and troubleshoot a switched network **Tool: Packet Tracer**
TASK 5	To install and configure Dynamic Host Configuration Protocol (DHCP)
TASK 6	To install and configure File Transfer Protocol (FTP) and Print Server
TASK 7	To configure firewall for security **Tool: Packet Tracer**
TASK 8	To perform system audit and analyze the software and hardware **Tool: WinAudit**
TASK 9	To identify vulnerabilities/ attacks using machine learning techniques **Tool: Weka**
TASK 10	To classify attacks based on known signature using machine learning techniques **Tool: Weka**

Part-2

Use Cases:

10. **Home Automation System:** You can have multiple sensors installed for different purpose at your home. For example, a fire sensor in kitchen and fireplace is really handy in the event of fire. Temperature sensors can perform climate control for you. An automated heating and cooling system can do it for you automatically. Electric shock sensors can sense short circuits in various part of underground wiring. In the same way voltage sensor can inform you about voltage fluctuations and thus save electrical appliances from damage.

    Task: To configure all of these sensors in the form of *Wireless Mesh Topology Personal Area Network* (using NS2).

11. **RailNet:** Provide a brief description for each DHCP message that would be exchanged, in order, if the DHCP server is in the middle of rebooting during an initial lease request but comes up seconds later. Answers might be slightly different depending on exactly when you choose for the DHCP server to come online.

    DHCP is Dynamic Host Configuration Protocol is a protocol that is responsible for assigning IP addresses automatically to the required host. DHCP is used in enterprises network to reduce configuration efforts.

    Task: Provide a rough description of the timing of the messages and/or the duration between them.

12. **Intrusion Detection System:** It is a software application to detect network intrusion using various machine learning algorithms. IDS monitors a network or system for malicious activity and protects a computer network from unauthorized access from users, including perhaps insider. The intrusion detector learning task is to build a predictive model (i.e. a classifier) capable of distinguishing between 'bad connections' (intrusion/attacks) and a 'good (normal) connections'.

    Task: To build a network intrusion detector using Weka tool or python packages.

Total: 60 Hours

H. Learning Resources (in IEEE Format)

i. Text Books:

1. Craig Hunt, "TCP/IP Network Administration", O'Reilly, 3rd Edition, 2002. (Unit 1, Unit 2 & Unit 3)
2. J. Michael Stewart, Jones & Bartlett Learning, "Network Security, Firewalls and VPNs", 2013. (Unit 4)
3. Matt Bishop, "Computer Security", Pearson Education, 2nd Edition, 2019. (Unit 5)

ii. Reference Book:

1. "TCP/IP Network Administration Guide", SunSoft Microsystems Inc, 1st Edition, 1999. (Unit 1 & Unit 2)

iii. Online References:

1. Neal Krawetz, "Introduction to Network Security", Charles River Media, Boston, 1st Edition, 2007, Accessed: June 2013, [Online] Available: cuhttp://index-of.es/Hack/Introduction_to_Network_Security.pdf