GUJARAT TECHNOLOGICAL UNIVERSITY

Advanced Wireless and Mobile Networks
SUBJECT CODE: 3712311

Type of course: Elective

Prerequisite: None

Rationale: Wireless communications is one of the fastest growing segments of the telecommunication industry. Wireless communication systems such as cellular, cordless, satellite phones, wireless local area networks are used widely. However, wireless transmission has many challenges such as wireless medium unreliability, power management, spectrum use, security, locations/routing.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction to Wireless Networks Evolution of Wireless Networks, Challenges	1	2
2	Wireless communications Principles and fundamentals – Introduction, Electromegnetic spectrum, Wireless propagation characteristics and modeling, Analog and Digital Data Transmission, Modulation Techniques for wireless systems,Multiple access for wireless systems, Performance increasing techniques for wireless networks, the cellular concept,The Ad hoc and Semi Ad hoc Concepts,Wireless services, Data delivery approaches	6	10
3	WIRELESS CELLULAR NETWORKS – First Generation(1G) Cellular systems- Inroduction Second Generation(2G) Cellular systems- GSM,GPRS,cordless telephony Third Generation(3G) Cellular systems – Introduction,3G spectrum allocation, Third generation service classes and applications, third generation standards Fourth Generation(4G) Cellular systems – Introduction, 4G services and applications	5	8
4	Wireless LAN – Infrared vs radio transmission, infrastructure and ad hoc network, IEEE 802.11	6	15
5	Mobile Network Layer- Mobile IP, Dynamic host configuration protocol, Mobile ad hoc networks	6	10
6	Personal Area networks(PAN) Introduction to PAN Technology and Application, Bluetooth, Home RF.	4	10
7	WiMAX -	4	10

	WiMAX (Physical layer, Media access control, Mobility and Networking), IEEE 802.22 Wireless Regional Area Networks, IEEE 802.21 Media Independent Handover		
8	Mobile Transport Layer – Traditional TCP,classical TCP improvements, TCP over 2.5/3G wireless networks	4	10
9	Wireless application protocol – Architecture, wireless datagram protocol,wireless transport layer security, wireless transaction protocol,wireless session protocol,wireless application environment	5	10
10	Security Issues in Wireless systems – Need for wireless network security,attacks on wireless networks, security services, Wired equivalence privacy(WEP) protocol, Weaknesses in WEP,	3	10
11	ADVANCED TOPICS IEEE 802.11x and IEEE 802.11i standards, Introduction to Vehicular Adhoc Networks	4	5

Reference Books:

1, Schiller J., Mobile Communications, Addison Wesley 2000

2. P.Nicopolitidis,M.S.Obaidat,G.I.Papadimitriou,A.S.Pomportsis, "wireless networks", WILEY 2014

2. Stallings W., Wireless Communications and Networks, Pearson Education 2005

3. Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc 2002

4. Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc 2000

5. Pandya Raj, Mobile and Personal Communications Systems and Services, PHI 200

After completion of course, students would be able to:

1. Demonstrate advanced knowledge of networking and wireless networking and understand various types of wireless networks, standards, operations and use cases.
2. Be able to design WLAN, WPAN, WWAN, Cellular based upon underlying propagation and performance analysis.
3. Demonstrate knowledge of protocols used in wireless networks and learn simulating wireless networks. Design wireless networks exploring trade-offs between wire line and wireless links.
4. Develop mobile applications to solve some of the real world problems.

List of Experiments:

1. Create network of wireless nodes by connecting laptops, mobiles or create wireless network through simulator and perform Time division multiple access.
2. Create network of wireless nodes by connecting laptops, mobiles or create wireless network through simulator and perform frequency division multiple access.
3. Create network of wireless nodes by connecting laptops, mobiles or create wireless network through simulator and perform code division multiple access.
4. Write an experiment on network simulator to measure the quality of service parameters end to end delay and throughput for ad hoc network of different number of nodes.
5. Write an experiment to perform denial of service attack on wireless network.
6. Write an experiment on simulator to generate vehicular ad hoc network.

Major Equipment:

Computer systems having following minimum technical configurations
Processor:i3 or i5 or higher
RAM : minimum 4 GB
HDD : 1 TB
Internet and wifi connectivity
Licence Window/Linux operating system

List of Open Source Software/learning website:

1) **nptel.ac.in**

GUJARAT TECHNOLOGICAL UNIVERSITY
SUBJECT NAME: Smart Sensors and Internet of Things
SUBJECT CODE: 3712312
ME 1st Semester

Type of course: Elective I

Prerequisite: Fundamentals of computer network, wireless sensor network, communication & internet technology, web technology, information security.

Teaching scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Sr. No.	Syllabus Content	No. of Hours
1	**IoT & Web Technology** The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.	8
2	**M2M to IoT – A Basic Perspective**– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. **M2M to IoT-An Architectural Overview**– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.	10
3	**IoT Architecture -State of the Art –** Introduction, State of the art, **Architecture Reference Model-** Introduction, Reference Model and architecture, IoT reference Model, **IoT Reference Architecture-** Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.	10
4	**IoT Applications for Value Creations** Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.	8
5	**Internet of Things Privacy, Security and Governance** Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in	8

	Smart Cities, Security	

Reference Books:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, **"From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence",** 1st Edition, Academic Press, 2014.
2. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013, ISBN: 978-87-92982-96-4 (EBook), ISBN: 978-87-92982-73-5 (Print)
3. Vijay Madisetti and Arshdeep Bahga, **"Internet of Things (A Hands-on-Approach)",** 1st Edition, VPT, 2014.
4. Francis daCosta, **"Rethinking the Internet of Things: A Scalable Approach to Connecting Everything",** 1st Edition, Apress Publications, 2013
5. Cuno Pfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493-9357-1

Course Outcome:

After learning the course, the student will be able:

1. Understand the vision of IoT from a global context.
2. Understand the application of IoT.
3. Determine the Market perspective of IoT.
4. Use of Devices, Gateways and Data Management in IoT.
5. Building state of the art architecture in IoT.
6. Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints

List of Experiments:

1. Define and Explain Eclipse IoT Project.
2. List and summarize few Eclipse IoT Projects.
3. Sketch the architecture of IoT Toolkit and explain each entity in brief.
4. Demonstrate a smart object API gateway service reference implementation in IoT toolkit.
5. Write and explain working of an HTTP- to-CoAP semantic mapping proxy in IoT toolkit.
6. Describe gateway-as-a-service deployment in IoT toolkit.
7. Explain application framework and embedded software agents for IoT toolkit.
8. Explain working of Raspberry Pi.
9. Connect Raspberry Pi with your existing system components.
10. Give overview of Zetta.

Major Equipment:

Raspberry pi, Arduino

List of Open Source Software/learning website:

- https://github.com/connectIOT/iottoolkit
- https://www.arduino.cc/
- http://www.zettajs.org/
- Contiki (Open source IoT operating system)
- Arduino (open source IoT project)
- IoT Toolkit (smart object API gateway service reference implementation)
- Zetta (Based on Node.js, Zetta can create IoT servers that link to various devices and sensors)

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: INFORMATION TECHNOLOGY
SUBJECT NAME: BIG DATA ANALYTICS
SUBJECT CODE: 3712313

Type of course: Elective

Prerequisite: Data Structure, Computer Architecture and Organization

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

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.	7	14%
2	Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer peer replication, sharding and replication, sharding in MongoDB, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.	9	20%
3	Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures	9	18%
4	MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats	10	20%

5	Hbase, data model and implementations, Hbase clients, Hbase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration.	7	14%
6	Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.	6	14%
	Total	**48**	**100%**

Reference Books:

1. DT Editorial Services, Big Data Black Book, Dreamtech Press
2. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
3. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
4. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
5. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
6. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
7. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
8. Alan Gates, "Programming Pig", O'Reilley, 2011.
9. MongoDB: The definitive Guide, 3rd Edition, O'Reilley, 2016.

Course Outcome:

After completion of course, students would be able to:
- Describe big data and use cases from selected business domains
- Explain NoSQL big data management
- Install, configure, and run Hadoop and HDFS
- Understand use of MongoDB to support deployment with very large data sets and high throughput operations
- Perform map-reduce analytics using Hadoop
- Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics

List of Experiments:

1. To install Hadoop 3.X on Ubuntu.
2. To count words in the input document on Hadoop using Map Reduce Programming.
3. To install MongoDB and perform various commands in MongoDB.
4. To load a local file on to HDFS from local file system.
5. To install Cassandra and perform CRUD operations on Cassandra.
6. To use Pig in Hadoop local mode and Map-reduce mode.
7. To perform relational operations on database using pig.

List of Open Source Software/learning website:

Apache Hadoop, Apache Cassandra, Mongo DB, Pig

GUJARAT TECHNOLOGICAL UNIVERSITY

English for Research Paper Writing
SUBJECT CODE: 3700001
SEMESTER: I/II

Type of course: Audit course

Prerequisite: -

Rationale: -

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
2	0	0	0	50	0	0	0	50

Content

Sl. No.	Topic	Teaching Hours	Module Weightage (%)
1.	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4	17
2.	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4	17
3.	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	4	17
4.	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	4	17
5.	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	4	16
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4	16

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Course Outcome:

At the end of the course, the student will be able to:
1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

GUJARAT TECHNOLOGICAL UNIVERSITY

Constitution of India
SUBJECT CODE: 3700005
SEMESTER: I/II

Type of course: Audit course

Prerequisite: -

Rationale: -

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
2	0	0	0	50	0	0	0	50

Content

Sl. No.	Topic	Teaching Hours	Module Weightage (%)
1.	**History of Making of the Indian Constitution** History Drafting Committee, (Composition & Working)	4	17
2.	**Philosophy of the Indian Constitution:** Preamble Salient Features	4	17
3.	☐ **Contours of Constitutional Rights & Duties:** ☐ Fundamental Rights ☐ Right to Equality ☐ Right to Freedom ☐ Right against Exploitation ☐ Right to Freedom of Religion ☐ Cultural and Educational Rights ☐ Right to Constitutional Remedies ☐ Directive Principles of State Policy ☐ Fundamental Duties.	4	17
4.	☐ **Organs of Governance:** ☐ Parliament ☐ Composition ☐ Qualifications and Disqualifications ☐ Powers and Functions ☐ Executive ☐ President ☐ Governor ☐ Council of Ministers ☐ Judiciary, Appointment and Transfer of Judges, Qualifications ☐ ☐ Powers and Functions	4	17

5.	☐ **Local Administration:** ☐ District's Administration head: Role and Importance, ☐ Municipalities: Introduction, Mayor and role of Elected Representative, ☐ CEO of Municipal Corporation. ☐ Pachayati raj: Introduction, PRI: ZilaPachayat. ☐ Elected officials and their roles, CEO ZilaPachayat: Position and role. ☐ Block level: Organizational Hierarchy (Different departments), ☐ Village level: Role of Elected and Appointed officials, ☐ ☐ Importance of grass root democracy	4	16
6	☐ **Election Commission:** ☐ Election Commission: Role and Functioning. ☐ Chief Election Commissioner and Election Commissioners. ☐ State Election Commission: Role and Functioning. ☐ ☐ Institute and Bodies for the welfare of SC/ST/OBC and women.	4	16

Reference Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

Course Outcome:

At the end of the course, the student will be able to:
1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
2. To address the growth of Indian opinion regarding modern Indian intellectuals constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

GUJARAT TECHNOLOGICAL UNIVERSITY

RESEARCH AND IPR

M.E. SEMESTER: I

Rationale:

The purpose of this subject is to orient the students to the scientific methodology of research and presenting their thesis. Research constitutes primarily of literature review, giving critical comments on the literature reviewed and identifying the gap, problem formulation, modeling in either an analytical or experimental set up, validating the model and solving the problem you set for yourself.

At the end, student should be able to present and defend the solution he/she has found, in a simple and easy manner. Communicating the research outcomes, is an art wherein, you do not want to either undermine or over emphasise the content, within the short time limit given for such presentations. The balance of critical technicality and overall outcomes is the key to an effective presentation. The language, content and articulation should be such as to convey in a unified manner, the gist of your work.

To the Teacher:

It is envisaged that the teacher will discuss actual case studies to make the student understand the concepts of demonstration of examples during theory. Theory classes will be used to explain each of the concepts in Module 1 and 2. This syllabus is based on the model AICTE course prescribed in May2018.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
1	0	2	2	0	0	80	20	100

Content:

	Module 1 Starting Research	Teaching Hrs
1.1	**Find what is expected of you**	
	Identify specific requirements for evaluation/review and what constitutes completion of your work	
	Find where the source is available	
	Establish proper methods for finding the relevant material from the source.	
1.2	**Analyse the question**	
	Identify key areas in your field	
	Determine the nature and extension of papers that you should read	
1.3	**Identify the gaps**	

	Learn to Critique existing knowledge and how to find the gap	
1.4	**Formulate the Problem Statement**	
	Understand what should be the key aspects of your problem statement	
	Examples of effective and ineffective Titles	
1.5	**Validation**	
	Identify problem and experimental/theoretical data for comparison with your model	
	Learn how to extrapolate/scale data for validation	
	Find what is acceptable level of error and justification thereof	
Module 2	**Finding Good Literature**	
2.1	**Decide which sources you will need**	
	Differentiate between journals, conferences, books, magazines and their quality	
	Understand how to establish their quality and authenticity	
2.2	**Finding Information**	
	How to conduct effective searches	
	How to find relevant papers related to your area of research	
	How to capture critical information	
2.3	**Identify main ideas in scholarly literature**	
	Understand and identify the bias, theoretical position and evidence produced	
2.4	**Write notes to organize your ideas**	
	Compare ideas and concepts from different papers	
Module 3	**Writing and Presenting your Work**	
3.1	**Effective technical writing**	
	How to write Report, Paper, Developing a Research Proposal, Format of research proposal	
3.2	**Build your argument**	
	Recognise the importance of emphasizing your point	
	Distinguish between your point and the evidence available	
	Acknowledge the evidence	
3.3	**Review and finalize your work**	
	Know and follow the Process of reviewing and proof reading your work	
	Use feedback to improve your work	
3.4	**Check the logistics of your presentation**	
	Identify the key message of your presentation	
	Understand the expectations and what will be the key review points	
3.5	**Develop the structure of your presentation**	
	Understand the key components of an oral presentation	
	Know the usual structure of a good presentation	
3.6	**Prepare for delivery of your Oral presentation**	
	Rehearse and time your presentation	
	Prepare to answer questions from the audience: Fundamental concepts should be spoken from memory as reviewer will be looking for evidence of your thorough understanding.	
	Read more than the content you are presenting; keep sources ready on hand for reference;	
Module 4	**Intellectual Property**	
4.1	**Patents, Designs, Trade and Copyright.,**	
	Process of Patenting and Development: Technological research innovation, patenting, development.	

4.2	**International Scenario:**		
	International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		
4.3	**Patent Rights**		
	Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications		
4.4	**New Developments in IPR**		
	Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies		

Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Propertyin New Technological Age", 2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Outcome:

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

1. Conduct a quality literature review and find the research gap.
2. Identify an original and relevant problem and identify methods to find its solution
3. Validate the model
4. Present and defend the solution obtained in an effective manner in written or spoken form.
5. Follow research ethics
6. Understand IPR protection for further research and better products

GUJARAT TECHNOLOGICAL UNIVERSITY

Mathematical Foundation of Computer Science
SUBJECT CODE: 3710214

Type of course: Core

Prerequisite: Discrete Mathematics

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total
L	T	P	C	Theory Marks		Practical Marks		Marks
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No	Content	Total Hrs	% Weightage
1	Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains	7	15
2	Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood	7	15
3	Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of overfitting model assessment	8	16
4	Graph Theory: Isomorphism, Planar graphs, graph colouring, hamilton circuits and euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems	11	23
5	**Computer science and engineering applications:** Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning	10	21
6	Recent Trands in various distribution functions in mathmatical field of computer science for varying fields like bioinformatic, soft computing, and computer vision	5	10

Reference Books:

1. John Vince, Foundation Mathematics for Computer Science, Springer
2. K. Trivedi.Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.
3. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis

4. Alan Tucker, Applied Combinatorics, Wiley

Course Outcome:

After learning the course the students should be able to:
- To understand the mathematical fundamentals that is prerequisites for avariety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning
- To developthe understanding ofthe mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency
- To study various sampling and classification problems.

List of Experiments:
1. Analyze the concpt of randomization. Implement a program in a language that supports graphics to Push the balls from left and right allowing random movement and then let them fall in rectangle bins.Show graphically how they form curve
2. Consider that there are two parties party1 and party2 contesting for elections. Consider candidate from either party1 or party2. Consider voting population and ask them about their likelihood to vote for the candidate from party1. Now Ask the population again to show their likelihood for candidate after candidate gives speech. Now again rate the candidate through voting population. Implement a program to do this. Use WEKA tool to simulate this.
3. Write a program that takes two inputs- size of the house(no of rooms) and location of the house and accordingly give price of the house. Classify the house as very costly,costly,affordable,cheap.
4. Consider website of your institute. Represent the link structure by directed graph. Apply and implement algorithm to traverse the graph and to reach a faculty's web page in your department
5. Graph theory problem – there are k aircrafts and have to be assigned n flights. The time interval of ith flight is (ti1,ti2). If the time interval overlaps for the flights the same aircraft cannot be assigned to both the flights.Vertices of the graph are flights.Two vertices are connected if the corresponding time intervals overlap. Simulate the problem by applying graph theory. Use simulation tool to simpulate or programming language to implement graph

GUJARAT TECHNOLOGICAL UNIVERSITY

Advanced Data Structures
SUBJECT CODE: 3710215

Type of course: Core

Prerequisite: UG level course in Data Structures

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No	Content	Total Hrs	% Weightage
1	**Dictionaries:** Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. **Hashing:** Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing	7	15
2	**Skip Lists:** Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists	5	10
3	**Trees:** Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees	9	19
4	**Text Processing:** Sting Operations, Brute-Force Pattern Matching, The Boyer- Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.	12	25
5	**Computational Geometry:** One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.	10	21
6	Recent Trands in Hashing, Trees, and various computational geometry methods for effeciently solving the new evolving problem	5	10

Reference Books:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

Course Outcome:

After learning the course the students should be able to:
- Understand the implementation of symbol table using hashing techniques
- Develop and analyze algorithms for red-black trees, B-trees and Splay trees
- Develop algorithms for text processing applications
- Identify suitable data structures and develop algorithms for computational geometry problems

List of Experiments:
(Note: At least 12 Practicals should be performed from the list.)

1. Write a program which creates Binary Search Tree. And also implement recursive and non-recursive tree traversing methods inorder, preorder and post-order for the BST.

2. Write a program to implement any two hashing methods. Use any one of the hashing method to implement Insert, Delete and Search operations for Hash Table Management.

3. Explain Dictionary as an Abstract Data Type. Implement Dictionary using suitable Data Structure.

4. Write a program which creates AVLTree. Implement Insert and Delete Operations in AVL Tree. Note that each time the tree must be balanced.

5. Implement Red-Black Tree.

6. Implement 2-3 Tree.

7. Implement B Tree.

8. Implement a program for String Matching using Boyer-Moore Algorithm on a text file content.

9. Implement a program for String Matching using Knuth-Morris-Pratt Algorithm on a text file content.

10. Implement Huffman-Coding Method. Show the result with suitable example.

11. Implement Longest Common Subsequence(LCS) Problem using Dynamic Programming Method. Show the DP table and also find the particular solution of given strings.

12. Implement One Dimensional and Two Dimensional Range Searching in any language.

13. Write a program which creates Priority Search Tree. Implement Insert and Search Operations in this Tree.

14. Write a program which creates Skip Lists. Implement Insert, Search and Update Operations in Skip-Lists.

15. Design a simple search engine to display the possible websites upon entering a search query. Use suitable data structure for storage and retrieval.

16. Prepare a Report/Presentation on Recent trends on Hashing/Trees/Computational Geometry to solve ay of recent evolving problem in real world.

GUJARAT TECHNOLOGICAL UNIVERSITY

Wireless Sensor Networks
SUBJECT CODE: 3710217

Type of course: Elective

Prerequisite: None

Rationale: Advancements in the areas of sensor design, information technologies and wireless networks have evolved the wireless sensor networks. The wireless sensor networks connect the physical world to computing world. WSN is useful in developing a large number of applications, including the protection of civil infrastructure, habitat monitoring, agriculture, health care. However, the design, operation and performance is a challenging task.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction –Motivation, Definitions and background, challenges and constraints, Applications	2	2
2	Single Node Architecture – Hardware components, Energy consumption of sensor nodes, Operating systems and execution environments, examples of sensor nodes	3	3
3	Network Architecture – Sensor network scenarios, optimization goals, design principles, service interfaces,gateway concepts	4	5
4	Physical layer – Introduction, wireless channel and communication fundamentals,physical layer and transceiver design considerations in WSNs	3	5
5	MAC protocols – Fundamentals of MAC protocols, Low duty cycle protocols and wakeup concepts, contention based protocols, schedule based protocols, The IEEE 802.15.4 MAC protocol	4	10
6	Link Layer Protocols – Tasks and requirements, Framing, Link Management	4	5
7	Naming and addressing – Fundamentals, address and name management, Assignment of MAC address, Distributed assignment of locally unique addresses, content based and geographic addressing.	4	10
8	Time Synchronization, Localization and positioning – Time synchronization problem, protocols, properties of localization and positioning procedures, lateration problem, single hop localization, positioning in multihop environments	4	10

9	Routing protocols – Forwarding and routing, MANET protocols, gossiping and agent based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, geographic routing, Mobile nodes	8	20
10	Data centric and content based networking –Introduction, Data centric routing, Data aggregation, data centric storage	4	10
11	Transport layer and quality of service – The transport layer and QoS in wireless sensor networks, Coverage and deployment, Reliable data transport, single packet delivery, block delivery, congestion control and rate control	4	10
12	Security – Challenges of security, security attacks, Protocols and mechanisms for security, IEEE 802.15.4 and ZigBee Security	4	10

Reference Books:

1) Holger Karl and Andreas Willig, "Protocols and Architectures for wireless sensor networks, WILEY
2) W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks –Theory and Practice", Wiley 2010

3) KazemSohraby, Daniel Minoli and TaiebZnati, "wireless sensor networks -Technology, Protocols, and Applications", Wiley Interscience 2007
4) Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, "Wireless Sensor Network Technologies for the Information Explosion Era", springer 2010
5) Jun Zheng, Abbas Jamalipour, " Wireless Sensor Networks – A networking perspective", WILEY
6) Kazem Sohraby,Daniel Minoli,Taieb Znati, "wireless sensor Networks Technology, Protocols and applications", WILEY
7) Jr. Edgar H. Callaway, Wireless Sensor Networks: Architecture and Protocols, Auerbach, 2003
8) Fundamentals of Sensor Network Programming: Applications and Technology By Sridhar S. Iyengar, NandanParameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley
9) AzzedineBoukerche, Handbook of Algorithms for Wireless Networking and Mobile Computing, Chapman & Hall/CRC, 2006
10) Philip Levis, " TinyOS Programming"

Course Outcomes:

After completion of course, students would be able to:

- Describe and explain radio standards and communication protocols for wireless sensor networks.
- Explain the function of the node architecture and use of sensors for various applications.
- Be familiar with architectures, functions and performance of wireless sensor
- networks systems and platforms.

List of Experiments:

1) Implement a campus sensor communication application for assignment file transfer using Bluetooth.
2) Implement a campus sensor communication application for assignment file transfer using wireless LAN.
3) Implement a campus sensor communication application for assignment file transfer using ZigBee.
4) Implement a campus sensor communication application for assignment file transfer using WiMax/hotspot.

5) Implement TinyOS. Perform analysis of various routing protocols
6) Perform analysis of various routing protocols on sensor network simulator.
7) Perform analysis of various MAC protocol on sensor network simulator and find how it affects the energy efficiency.

Major Equipment:

Computer systems having following minimum technical configurations
Processor:i3 or i5 or higher
RAM : minimum 4 GB
HDD : 1 TB
Internet and wifi connectivity
Licence Window/Linux operating system

List of Open Source Software/learning website:

1) **nptel.ac.in**

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Data Science
SUBJECT CODE: 3710219

Type of course: Elective

Prerequisite: Data Structures, Basics of Probability and Statistics

Rationale: Data Science is a blend of many fields, including many sub domains of mathematics, computer science, computational science, statistics, and information science. In contrast to "pure" mathematicians, statisticians, or computer and information scientists, a data scientist has a breadth of experience across all of these fields, but may not have as much knowledge as a specialist in any particular field. This subject will help students to efficiently conduct computational analysis with their own knowledge domain.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**An Introduction to core concepts & technologies:** Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.	6	10%
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	7	15%
3	**Data analysis:** Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.	10	25%
4	**Data visualisation:** Introduction, Types of data visualisation, Data for visualisation: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.	11	25%
5	Applications of Data Science, Technologies for visualisation, Bokeh (Python)	7	15%
6	Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.	7	10%

Reference Books:

1. Doing Data Science, Cathy O'Neil and Rachel Schutt, Straight Talk From The Frontline. O'Reilly.
2. Introduction to Data Science, Davy Cielen, Arno D B Meysman and Mohamed Ali, Manning, dreamtech press
3. Practical Data Science, Nina Zumwl and John Mount, Manning, dreamtech press
4. The Data Science Handbook, Field Cady, Wiley
5. Getting Started with Data Science, Murtaza, Haider, Pearson
6. Data Science and Big Data Analytics, EMC Education Services, Wiley
7. Data Science, John D Kellehar, MIT Press
8. Mining of Massive Datasets. v2.1, Jure Leskovek, AnandRajaraman and Jeffrey Ullman, Cambridge University Press

Course Outcome:

After learning the course the students should be able to:

- Explain how data is collected, managed and stored for data science;
- Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists;
- Implement data collection and management scripts using MongoDB

List of Experiments

– Minimum 10 experiments based on the contents.
– Mini Project in a group of max. 3 students
– Writing a research paper on selected topic from content with latest research issues in that topic

Major Equipments:

- Modern System with related software

List of Open Source Software/learning website:

https://www.analyticsvidhya.com/blog/2016/01/complete-tutorial-learn-data-science-python-scratch-2/

https://www.rstudio.com/online-learning/

Additional Resources:

Books for Unit 1 and 2:

1. Data Mining Concepts & Techniques, J Han, M Kamber, J Pei ((chapter 2 & 3)
2. Data science process flowchart from "Doing Data Science", Cathy O'Neil and Rachel Schutt, 2013 (chapter 2)
3. Data Science and Big Data Analytics, EMC Education Services, Wiley

Unit 1: An introduction to core concepts and technologies
https://www.edureka.co/blog/what-is-data-science/
https://intellipaat.com/blog/what-is-data-science/

Data types:

https://www.youtube.com/watch?v=hZxnzfnt5v8
https://www.youtube.com/watch?v=zHcQPKP6NpM&t=247s
https://www.youtube.com/watch?v=zHcQPKP6NpM&t=247s
http://www.mymarketresearchmethods.com/types-of-data-nominal-ordinal-interval-ratio/

Tools:
https://www.ngdata.com/top-tools-for-data-scientists/

8 open Source Big Data Tools to use in 2018:

https://towardsdatascience.com/8-open-source-big-data-tools-to-use-in-2018-e35cab47ca1d

Basic Libraries for Data Science:
https://www.upwork.com/hiring/data/15-python-libraries-data-science/

Unit 2: Data collection and management

Data collection:
http://bigdata-madesimple.com/3-effective-methods-of-data-collection-for-market-research/
Data Wrangling with example:
https://towardsdatascience.com/intro-to-data-science-part-2-data-wrangling-75835b9129b4
https://medium.fr7eecodecamp.org/discovering-the-secrets-of-baseball-with-data-56f793852de0
Data Analysis with example:
https://medium.com/@williamkoehrsen/data-analysis-with-python-19434f5d6324
Data cleaning with example:
https://www.kdnuggets.com/2016/03/doing-data-science-kaggle-walkthrough-cleaning-data.html
5 APIS a data scientist must know:
https://www.analyticsvidhya.com/blog/2016/11/an-introduction-to-apis-application-programming-interfaces-5-apis-a-data-scientist-must-know/

Data storage

https://searchstorage.techtarget.com/definition/big-data-storage

http://www.enterprisestorageforum.com/storage-management/storage-trends/top-10-trends-for-data-storage-with-big-data-analytics.html

https://www.computerweekly.com/tip/Big-data-storage-management-challenges-and-how-to-deal-with-them

Multiple data sources:

https://www.allerin.com/blog/top-5-sources-of-big-data

http://tdan.com/combining-data-from-multiple-sources-join-integrate-blend/19877

https://www.techrepublic.com/blog/big-data-analytics/use-normalization-and-etl-to-get-the-big-data-results-you-want/

https://www.youtube.com/watch?v=f0nMfV1GvOg

Books for Units 3 to 6

Book1: Data Mining Concepts and Techniques by Jiawei Han, MichelineKamber and Jian Pei

Book2: Statistics and Data Analysis by A. Abebe (available online in .pdf format

Unit 3 Data Analysis

- For Introduction, Terminology and Concepts
    - Chapter 3 of Book1 for Data analysis process
    - https://www.tutorialspoint.com/excel_data_analysis/data_analysis_overview.htm
    - https://www.tutorialspoint.com/excel_data_analysis/data_analysis_process.htm
- Introduction to statistics, central tendencies and distributions, Variance, distribution properties and arithmetic
    - Section 2.2 (Basic Statistical Descriptions of Data) of book
    - http://statistics.wikidot.com/ch3
    - https://www.listendata.com/2014/04/descriptive-statistics.html
- Central Limit Theorem (CLT)
    - Chap. 6 from Book2
    - https://web.stanford.edu/class/archive/cs/cs109/cs109.1178/lectureHandouts/190-central-limit-theorem.pdf
    - https://towardsdatascience.com/understanding-the-central-limit-theorem-642473c63ad8
    - https://www.tutorialspoint.com/statistics/central_limit_theorem.htm
- Basic Machine Learning Algorithms, Linear regression, SVM, Naïve Bayes
    - **Machine Learning**
        - https://www.geeksforgeeks.org/machine-learning/(What is machine learning, applications of machine learning, classification of machine learning methods)
    - **Naïve Bayes**
        - Section 8.3 from Book1
        - https://www.geeksforgeeks.org/naive-bayes-classifiers/
    - **SVM**
        - Section 9.3 from Book1
        - https://machinelearningmastery.com/support-vector-machines-for-machine-learning/
        - https://www.analyticsvidhya.com/blog/2017/09/understaing-support-vector-machine-example-code/
    - **Linear Regression**
        - http://cs229.stanford.edu/notes/cs229-notes1.pdf
        - https://www.geeksforgeeks.org/linear-regression-python-implementation/
        - http://ufldl.stanford.edu/tutorial/supervised/LinearRegression/

Unit 4 Data Visualization

- Introduction
    - Section 2.3 from Book1
- Types of data visualization
    - https://info.datalabsagency.com/blog/data-visualization-news/15-most-common-types-of-data-visualisation , https://datavizcatalogue.com/
- Data for visualization
    - Data types (already covered in Unit 1)
    - Data Encoding

- https://www.oreilly.com/library/view/designing-data-visualizations/9781449314774/ch04.html
    - http://paldhous.github.io/ucb/2016/dataviz/week2.html
    - http://www.faculty.jacobs-university.de/llinsen/teaching/340131/Lecture03.pdf
- Retinal variables, mapping variables to encoding, visual encoding
    - https://www.targetprocess.com/articles/visual-encoding/
    - http://vda.univie.ac.at/Teaching/Vis/13s/LectureNotes/05_visual_encodings.pdf
    - https://www.cs.sfu.ca/~torsten/Teaching/Cmpt467/LectureNotes/05_visual_mappings.pdf

Unit 5

- Applications of Data Science – Applications in healthcare, finance, ecommerece, education, and agriculture can be covered.
    https://www.analyticsvidhya.com/blog/2015/09/applications-data-science/
    - Healthcare:
        - https://medium.com/activewizards-machine-learning-company/top-7-data-science-use-cases-in-healthcare-cddfa82fd9e3
        - https://www.datapine.com/blog/big-data-examples-in-healthcare/
        - http://article.sciencepublishinggroup.com/pdf/10.11648.j.ajtab.20180402.14.pdf
    - Finance
        - https://www.mastersindatascience.org/industry/finance/
        - https://www.techemergence.com/predictive-analytics-in-finance/
    - E-commerce:
        - https://towardsdatascience.com/5-data-science-project-every-e-commerce-company-should-do-8746c5ab4604
        - https://www.datascience.com/blog/data-science-for-ecommece-businesses-predictive-modeling
        - https://dataconomy.com/2017/07/6-ways-use-big-data-ecommerce/
    - Education:
        - https://www.expresscomputer.in/magazine/data-analytics-in-education-sector-to-see-high-growth/14468/
        - https://www.analyticsindiamag.com/top-6-ways-make-education-institutions-smarter-data-analytics/
        - https://www.allerin.com/blog/4-ways-big-data-is-transforming-the-education-sector
    - Agriculture:
        - https://www.analyticsvidhya.com/blog/2018/05/data-analytics-in-the-indian-agriculture-industry/
        - https://www.wur.nl/upload_mm/6/0/4/307c3061-35ea-4339-a33b-d21f047d2d38_Wolfert%20et%20al%20Big%20Data%20in%20Smart%20Farming.pdf
        - https://www.sciencedirect.com/science/article/pii/S0308521X16303754
- Technologies for visualization
    - https://tdwi.org/articles/2011/11/09/research-excerpt-data-visualization-technology.aspx
- Bokeh (Python)
    - https://bokeh.pydata.org/en/latest/
    - https://www.analyticsvidhya.com/blog/2015/08/interactive-data-visualization-library-python-bokeh/

Unit 6

- Recent trends in various data collection techniques -
  https://www.tutorialspoint.com/statistics/data_collection.htm https://avaresearch.com.au/different-types-of-data-collection-methodologies/
- Various visualization techniques – already covered in Unit 4
- Application development methods used in data science
  - Python Programming
  - R Programming

  **Students must be able to implement concepts learned in data science (concepts learned in previous units) using Python and R programming

GUJARAT TECHNOLOGICAL UNIVERSITY

Optimization Techniques
SUBJECT CODE: 3712310

Type of course: Elective

Prerequisite: Mathematical concepts such as Linear Algebra, Numerical methods

Rationale:. The objective of this course is to provide insight to the mathematical formulation of real world problems. To optimize these mathematical problems using nature based algorithms. And the solution is useful specially for NP-Hard problems..

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total
L	T	P	C	Theory Marks		Practical Marks		Marks
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Unit 1:** Engineering application of Optimization, Formulation of design problems as mathematical programming problems.	7	15
2	**Unit 2:** General Structure of Optimization Algorithms, Constraints, The Feasible Region.	7	15
3	**Unit 3:** Branches of Mathematical Programming: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming, Semi Definite Programming.	11	25
4	**Unit 4:** Optimization Algorithms like Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc.	11	20
5	**Unit 5:** Real life Problems and their mathematical formulation as standard programming problems.	6	12
6	**Unit 6:** Recent trends: Applications of ant colony optimization, genetics and linear and quadratic programming in real world applications.	6	13

Reference Books:

1. Laurence A. Wolsey (1998). Integer programming. Wiley. ISBN 978-0-471-28366-9.
2. Practical Optimization Algorithms and Engineering Applications Andreas Antoniou.

3. An Introduction to Optimization Edwin K., P. Chong & Stanislaw h. Zak.

4. Dimitris Bertsimas; Robert Weismantel (2005). Optimization over integers. Dynamic Ideas. ISBN 978-0-9759146-2-5.

5. John K. Karlof (2006). Integer programming: theory and practice.CRC Press. ISBN 978-0-8493-1914-3.

6. H. Paul Williams (2009). Logic and Integer Programming. Springer. ISBN 978-0-387-92279-9.

7. Michael Jünger; Thomas M. Liebling; Denis Naddef; George Nemhauser; William R. Pulleyblank; Gerhard Reinelt; Giovanni Rinaldi; Laurence A. Wolsey, eds. (2009). 50 Years of Integer Programming 1958-2008: From the Early Years to the State-of-the- Art. Springer. ISBN 978-3-540-68274-5.

8. Der-San Chen; Robert G. Batson; Yu Dang (2010). Applied Integer Programming: Modeling and Solution. John Wiley and Sons. ISBN 978-0-470-37306-4.

Course Outcome:

After learning the course the students should be able to:

- Formulate optimization problems.
- Understand and apply the concept of optimality criteria for various types of optimization problems.
- Solve various constrained and unconstrained problems in Single variable as well as multivariable.
- Apply the methods of optimization in real life situation.

Practicals & Assignments : Assignments based on Unit 3, Practical based on Unit 4, 5 and 6.