Course Structure

Pre-Ph.D. Course work
(Computer Science & Engineering)

(Effective from the Academic Session 2020-2021)

Department of Computer Science & Engineering and Applications
Sambalpur University Institute of Information Technology (SUIIT)
Sambalpur University, Jyoti Vihar-768019, Burla

Program Outcomes

PO1	Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions
PO2	Effective Communication: Will be able to speak, read, write and listen clearly in person and through electronic media in English and in one Indian Language.
PO3	Social Interaction (Interpersonal Relation): Elicit views of others, mediate disagreements and prepared to work in team.
PO4	Entrepreneurship Capability: Demonstrate qualities to be prepared to become an entrepreneurship.
PO5	Ethics: Recognize different value systems including your own, understand the moral dimensions and accept responsibility for them.
PO6	Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.
PO7	Life-Long Learning: Acquire the ability to engage in independent and life-long learning in the context of socio-technological changes.

Course Structure
(Pre-Ph.D. Course Work in Computer Science and Engineering)

Semester – I						
Code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
CS711	Artificial Intelligence	Core Course	4	0	0	**4**
CS712	Wireless Sensor Networks & Applications	Core Course	4	0	0	**4**
CS713	Research Methodology	Core Course	**4**	**0**	**0**	**4**
CS714	Research and Publication Ethics	Core Course	3	0	0	**2**
CS715	Elective	Program Elective	4	0	0	**4**
CS716	Seminar and Research Review Work	Review Report (2CH) &Technical Seminar (2CH)	-	-	-	**4**
					Semester Total Credit:	**22**

LIST OF ELECTIVES				
S.No.	**Course Title**	**L**	**P**	**T**
1	Information Security	4	0	0
2	Data Warehousing and Data Mining	4	0	0
3	Machine Learning	4	0	0
4	Soft Computing	4	0	0
5	Information Theory and Coding	4	0	0
6	Digital Image Processing	4	0	0
7	Mobile Computing	4	0	0
8	Cloud Computing	4	0	0
9	Advance Database Systems	4	0	0
10	Advanced Computer Architecture	4	0	0
11	Parallel and Distributed Computing	4	0	0
12	High Performance Computing	4	0	0
13	Big Data Analytics	4	0	0
14	Internet of Things	4	0	0
15	Time Series Analysis	4	0	0
16	Combinatorial Optimization	4	0	0
17	Neural Networks & Deep Learning	4	0	0
18	Probability & Stochastic Process	4	0	0
19	Natural Language Processing	4	0	0
20	Computational Intelligence	4	0	0

NB:- Examination and Evaluation procedure for Technical Seminar, summer internship, Comprehensive Viva-Voce and Project Work (minor & Major) will be as per Academic & Examination Guidelines.

ARTIFICIAL INTELLIGENCE								
Course Code	**CS 711**	**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	**Concepts of Data structures and Design and Analysis of algorithms**							
Objective:	• To learn the difference between optimal reasoning VS human like reasoning. • To understand the notions of state space representation and heuristic search. • To learn different knowledge representation techniques. • To understand the applications of AI: namely Game playing, Theorem Proving. Expert systems, machine learning and Natural language Processing.							

CO1	Remember and understand the basic concepts/Principles of artificial intelligence.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I: **(10 Hours)**

Introduction to Artificial Intelligence, AI Problems, AI Techniques,Problems ,Problem Space and Search, Defining the problem as a state space search, Production system, Problem characteristics, **Heuristic search Technologies:** Generate and Test, Hill Climbing, Best First Search, Problem Reduction, means-end-analysis, optimal and A*, AND-OR Graphs, AO* Algorithms.

UNIT – II: **(12 Hours)**

Representation Knowledge using Predicate Logic, Representing simple facts in logic, Representing Instance and ISA relationships, Computable functions and Predicates, Resolution, Representing Knowledge using Rules, Forward Vs Backward Reasoning, Matching , Control Knowledge, , Weak slot and Filter structures, Semantic nets, Frames.

UNIT – III: **(12 Hours)**

Strong slot and Filter structures, Conceptual Dependencies, Scripts. Introduction to Non monotonic reasoning ,Logics for Non monotonic reasoning, Implementation : Depth First Search, Dependency-Directed Back Tracking, Justification based Truth Maintenance Logic based Truth Maintenance systems, Statistical Reasoning, Probability and Bayes Theorem, Certainty factors, Rule based Systems, Bayesian Networks, Dempster-Shaffer Theory.

UNIT – IV: **(12 Hours)**

Minmax search, alpha-beta cutoffs, Planning system, Goal stack planning, Hierarchical Planning, Natural Language Processing., Syntactic Analysis, Semantic Analysis, Discuses and Pragmatic Processing. Introduction and Fundamentals of Artificial Neural Networks, Biological Prototype, Artificial Neuron, Single Layer Artificial Neural Networks, Multilayer Artificial Neural Networks, Training of Artificial Neural Networks

TEXT BOOKS

1. Elaine Rich, Kevin Knight and ShivashankarB . Nair, Artificial Intelligence, 3/e, McGraw Hill

Education, 2008.

2. Neural Computing: Theory and practice- Waserman.

REFERENCE BOOKS:

1. Artificial Intelligence Structures and Strategies complex problem solving-George F. Lugar Pearson Education
2. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
3. Dan W. Patterson, Artificial Intelligence and Expert Systems, PHI.
4. Neural Networks: A Comprehensive Foundation 2/e- Symen Pearson Education.

WEB REFERENCES

1. http://nptel.ac.in/courses/106106126/
2. http://nptel.ac.in/courses/106105079/

INFORMATION SECURITY								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	**Number Theory and Cryptography**							
Objective:	• Explain the objectives of information security • Explain the importance and application of each of confidentiality, integrity, authentication and availability • Understand various cryptographic algorithms. • Understand the basic categories of threats to computers and networks • Describe public-key cryptosystem. • Describe the enhancements made to lPv4 by IPSec • Understand Intrusions and intrusion detection • Discuss the fundamental ideas of public-key cryptography. • Generate and distribute a PGP key pair and use the PGP package to send an encrypted e-mail message. • Discuss Web security and Firewalls							

CO1	Remember and understand the basic concepts/Principles of information security.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I: CLASSICAL ENCRYPTION TECHNIQUES (08 Hours)

Introduction: Cryptography, cryptanalysis, Security attacks, services & mechanisms, Symmetric Cipher Model, Substitution Techniques, Transportation Techniques, Cyber threats and their defense (Phishing Defensive measures), web based attacks, SQL injection & Defense techniques, Buffer overflow & format string vulnerabilities, TCP session hijacking (ARP attacks, route table modification) UDP hijacking (man-in-the-middle attacks).

UNIT-II: BLOCK CIPHERS , SYMMETRIC KEY CRYPTOGRAPHY & ASYMMETRIC KEY CRYPTOGRAPHY (12 Hours)

Traditional Block Cipher Structure, DES,Triple DES, Block Cipher Design Principles, AES-Structure, Transformation functions, Key Expansion, Blowfish, IDEA, Block Cipher Modes of Operations. **Public Key Cryptography**: Principles, public key cryptography algorithms, RSA Algorithms, Diffie Hellman Key Exchange, Elliptic Curve Cryptography

UNIT-III: CRYPTOGRAPHIC HASH FUNCTIONS & DIGITAL SIGNATURES (12 Hours)

Message authentication and Hash Functions, Authentication Requirements and Functions, Message Authentication, Hash Functions and MACs Hash and MAC Algorithms SHA-512, HMAC, Digital Signatures, NIST Digital Signature Algorithm. Key management & distribution. User Authentication: Remote user authentication principles, Kerberos

UNIT –IV: USER AUTHENTICATION, TRANSPORT LAYER SECURITY & EMAIL SECURITY IP SECURITY & INTRUSION DETECTION SYSTEMS

(08 Hours)

Transport Level Security: Web Security Requirements, Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Shell(SSH) **Electronic Mail Security**: Pretty Good Privacy (PGP) and S/MIME. **IP Security:** IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management.Firewalls:Need for Fire wall,Types of Firewall , Firewall Designing principle

TEXT BOOKS:

1. Cryptography and Network Security - Principles and Practice: William Stallings, Pearson Education, 6th Edition
2. Introduction to Computer Networks & Cyber Security, ChwanHwa Wu, J.David Irwin, CRC press
3. Hack Proofing your Network, Russell, Kaminsky, Forest Puppy, Wiley Dreamtech.

REFERENCE BOOKS

1. Cryptography and Network Security: C K Shyamala, N Harini, Dr T R Padmanabhan, Wiley India, 1 st Edition.
2. Cryptography and Network Security :ForouzanMukhopadhyay, McGraw Hill, 3rd Edition
3. Information Security, Principles, and Practice: Mark Stamp, Wiley India.
4. Principles of Computer Security: WM. Arthur Conklin, Greg White, TMH
5. Introduction to Network Security: Neal Krawetz, Cengage Learning
6. Network Security and Cryptography: Bernard Menezes, Cengage Learning

WEB REFERENCES

1. http://nptel.ac.in/courses/106105031/
2. https://onlinecourses.nptel.ac.in/noc18_cs07/preview

DATA WAREHOUSING AND DATA MINING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**

Category:	Core Course
Prerequisite:	Data Structure and Algorithm, Linear Algebra, Basics of Web programming
Objective:	This course deals with evolving multidimensional intelligent model from a typical system, representation of multi-dimensional data for a data warehouse, discovering the knowledge imbibed in the high dimensional system, finding the hidden interesting patterns in data, and gives the idea to evaluate various mining techniques on complex data objects.

CO1	Remember and understand the basic concepts/Principles of data warehousing and data mining.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT –I: INTRODUCTION TO DATA WAREHOUSING AND ARCHITECTURE (08 Hours)

Evolution of Decision Support Systems- Data warehousing Components –Building a Data warehouse, Data Warehouse and DBMS, Data marts, Metadata, Multidimensional data model, OLAP vs OLTP, OLAP operations, Data cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations

UNIT –II: DATA WAREHOUSE PROCESSAND ARCHITECTURE (08 Hours)

Types of OLAP servers, 3–Tier data warehouse architecture, distributed and virtual data warehouses. Data warehouse implementation, tuning and testing of data warehouse. Data Staging (ETL) Design and Development, data warehouse visualization, Data Warehouse Deployment, Maintenance, Growth, Business Intelligence Overview- Data Warehousing and Business Intelligence Trends - Business Applications.

UNIT –III: INTRODUCTION TO DATA MINING AND CLASSIFICATIONS (14 Hours)

Data mining-KDD versus data mining, Stages of the Data Mining Process-task primitives, Data Mining Techniques -Data mining knowledge representation – Data mining query languages, Integration of a Data Mining System with a Data Warehouse – Issues, Data preprocessing – Data cleaning, Data transformation, Feature selection, Dimensionality reduction, Discretization and generating concept hierarchies-Mining frequent patterns- association-correlation.

Decision Tree Induction - Bayesian Classification – Rule Based Classification –Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods.

UNIT –IV: CLUSTERING,ADVANCES IN DATA MINING (10 Hours)

Clustering techniques – , Partitioning methods- k-means Hierarchical Methods - distance-based agglomerative and divisible clustering, Mining complex data objects, Spatial databases, temporal databases, Multimedia databases, Time series and Sequence data; Text Mining –Graph mining-web mining-Application and trends in data mining.

TEXT BOOKS:

1. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, third edition2011, ISBN: 1558604898.
2. Alex Berson and Stephen J. Smith, "Data Warehousing, Data Mining & OLAP", Tata McGraw Hill Edition, Tenth Reprint 2007.
3. G. K. Gupta, "Introduction to Data Min Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006

REFERENCE BOOKS:

1. Mehmed kantardzic,"Datamining concepts, models, methods, and algorithms", Wiley Interscience, 2003.
2. Ian Witten, Eibe Frank, Data Mining; Practical Machine Learning Tools and Techniques, third edition, Morgan Kaufmann, 2011.
3. George M Marakas, Modern Data Warehousing, Mining and Visualization, Prentice Hall, 2003.

WEB REFERENCES

1. http://www.data-miners.com/

MACHINE LEARNING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Fundamental of computer science and mathematics							
Objective:	• To introduce concepts of learning. • To know decision tree learning and various learning methods.							

CO1	Remember and understand the basic concepts/Principles of machine learning.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I: (12 Hours)

General Introduction: Learning Problems, Choosing Training experience/Target Function, Representation of the target function, issues in machine learning.

Concept Learning: Concept learning task-Inductive Learning, Concept Learning as search, FIND-S algorithm, version spaces, The List then Eliminate algorithm, Representation of version spaces, The Candidate Elimination algorithm, Inductive bias.

UNIT – II: (12 Hours)

Decision Tree Learning: Decision tree representation, ID3 Learning algorithm, Entropy, Information gain, over fitting, reduced error pruning, Rule-post pruning.

Bayesian Learning: Bayes' Theorem and concept Learning, Bayes optimal classifier, Bayesian Belief Network.

UNIT – III: (12Hours)

Instance based Learning: Introduction, k-Nearest Neighbor Learning algorithm, distance weighted nearest neighbor learning algorithm, case based reasoning, lazy learner and eager learner.

Learning Set of Rules: Sequential covering algorithm, First Order Inductive Learning (FOIL), Induction as inverted deduction, Inverting resolution (First order resolution), Generalization, theta-subsumption and entailment, PROGOL.

UNIT – IV: (12Hours)

Analytical Learning: Inductive vs Analytical Learning, Prolog-EBG, Combining inductive and analytical learning.

TEXT BOOKS

1. Tom M. Mitchell, Machine Learning, Mac Graw Hill

REFERENCE BOOKS:

2. Christopher M. Bishop, Machine Learning and Pattern Recognition, Springer

SOFT COMPUTING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Probability and Statistics, Vectors, C++/Java/ Matlab programming							
Objective:	• To study the techniques of soft computing, especially evolutionary computation, fuzzy logic, GA and neural networks. • Applying hybrid of multiple techniques and choosing the appropriate technique for the problems that one want to solve.							

CO1	Remember and understand the basic concepts/Principles of soft computing
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I INTRODUCTION AND ARTIFICIAL NEURAL NETWORK (12 Hours)

Introduction to Soft Computing, Historical Development, Definitions, advantages and disadvantages, solution of complex real life problems.

Artificial Neural Network: Introduction, basic models, Hebb's learning, Adaline, Perceptron, Multilayer feed forward network, Back propagation, Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Deep Neural Network, Applications.

UNIT-II FUZZY LOGIC (12 Hours)

Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals &Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

UNIT-III GENETIC ALGORITHMS (12 Hours)

Evolutionary and Stochastic techniques: Genetic Algorithm (GA), different operators of GA, analysis of selection operations, Hypothesis of building blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Applications.

UNIT-IV HYBRID SYSTEMS (12 Hours)

Hybrid Systems: Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

TEXT BOOKS:

1. Jang, “Neuro-Fuzzy and Soft computing”, Sun, Mizutani, Pearson
2. Haykin, “Neural networks: a comprehensive foundation”,
3. Goldberg, “Genetic Algorithms”,
4. G.J. Klir& B. Yuan, “FuzzySets& Fuzzy Logic”, PHI.

REFERENCE BOOKS:

1. Anderson J.A., “An Introduction to Neural Networks”, PHI, 1999
2. Hertz J. Krogh, R.G. Palmer, “Introduction to the Theory of Neural Computation”, Addison-Wesley, California,
3. Melanie Mitchell, “An Introduction to Genetic Algorithm”, PHI, 1998.
4. “Neural Networks-A Comprehensive Foundations”, Prentice-Hall International, New Jersey, 1999.
5. Freeman J.A. & D.M. Skapura, “Neural Networks: Algorithms, Applications and Programming Techniques”, Addison Wesley, Reading, Mass, (1992).

INFORMATION THEORY AND CODING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Basics of probability theory							
Learning Objective:	To impart the knowledge of various error detection and correction coding techniques used in signal transmission.							

CO1	Remember and understand the basic concepts/Principles of information theory and coding.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I:INFORMATION THEORY AND SOURCE CODING (10 Hours)

Introduction to Information Theory, Uncertainty and Information, Mutual Information and Entropy, Source Coding, Huffman Coding, Shannon-Fano-Elias Coding, Arithmetic Coding, Lempel-Ziv Algorithm, Run Length Encoding, Channel Capacity, Channel Coding, Information Capacity Theorem, The Shannon Limit.

UNIT – II:ERROR CONTROL CODING (CHANNEL CODING) (10 Hours)

Error Correcting Codes, Matrix Description of Linear Block Codes, Equivalent Codes, Parity Check Matrix, Syndrome Decoding, Perfect codes, Hamming Codes, Cyclic Codes, Brust Error Correction, Fire Codes, Golay Codes

UNIT – III:BCH, CONVOLUTION AND TRELLIS (10 Hours)

Bose-Chaudhri Hocquenghem (BCH) codes, Decoding of BCH codes, Reed-Solomon Codes, Convolution Codes, Polynomial description , Turbo Codes , Turbo Decoding, Introduction to TCM, Performance Evaluation for AEGN Channel.

UNIT – IV:COMPRESSION TECHNIQUES, AUDIO AND VIDEO CODING (10 Hours)

Principle of Data Compression, Text Compression, Image Compression (GIF, TIFF, JPEG), Image Audio Coders, Video Compression, MPEG Video Standards (MPEG 1,2,3 and MP-3 Standard Sounds.

TEXT BOOKS

3. Information Theory, Coding and Cryptography, Ranjan Bose 2nd Edition, The McGraw-Hill.

REFERENCE BOOKS:

4. Information theory and Coding, Norman Abramson, McGraw-Hill electronic Series.
5. Information Coding Techniques, Dr. J. S. Chitode, Technical Publication.

DIGITAL IMAGE PROCESSING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	A fundamental study on matrix convention, probability theory and statistical principles are needed to be learned.							
Learning Objective:	The objective of the course is to understand a digital image and different processing techniques for the better analysis of an image.							

CO1	Remember and understand the basic concepts/Principles of digital image processing.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I: DIGITAL IMAGE FUNDAMENTALS AND TRANSFORMS (12 Hours)

Elements of visual perception: Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Image sampling and quantization Basic relationship between pixels: Basic geometric transformations-Introduction to Fourier Transform and DFT : Properties of 2D Fourier Transform , FFT, Separable Image Transforms ,Walsh – Hadamard – Discrete Cosine Transform, Haar, Slant – Karhunen – Loeve transforms. Perspective Projection, Spatial Domain Filtering, sampling and quantization.

UNIT – II: IMAGE ENHANCEMENT TECHNIQUES (10 Hours)

Spatial Domain methods: Basic grey level transformation, Histogram equalization, Image subtraction, Image averaging, Spatial filtering: Smoothing, sharpening filters, Laplacian filters, Frequency domain filters : Smoothing, Sharpening filters, Homomorphic filtering.

UNIT – III: IMAGE RESTORATIONAND IMAGE COMPRESSION (14 Hours)

Model of Image Degradation/restoration process: Noise models,Inverse filtering, Least mean square filtering, Constrained least mean square filtering, Blind image restoration, Pseudo inverse, Singular value decomposition.

Lossless compression: Variable length coding: LZW coding, Bit plane coding- predictive coding, DPCM.

Lossy Compression: Transform coding – Wavelet coding – Basics of Image compression standards: JPEG, MPEG, Basics of Vector quantization

UNIT – IV: IMAGE SEGMENTATION AND REPRESENTATION (12 Hours)

Edge detection: Thresholding, Region Based segmentation, Boundary representation: chair codes, Polygonal approximation, Boundary segments: boundary descriptors: Simple descriptors, Fourier descriptors, Regional descriptors, Simple descriptors, Texture

TEXT BOOKS:

6. Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods. Publisher: Pearson Education.

REFERENCE BOOKS:

7. Fundamentals of Digital Image Processing, By Anil K Jain
8. Digital Image Processing, By William K Pratt, John Willey (2001)
9. Image Processing Analysis and Machine Vision, By MillmanSonka, Vaclav hlavac, Roger Boyle, Broos/colic, Thompson Learniy (1999).
10. Digital Image Processing and Applications, By, B. Chanda, D. DuttaMagundar, Prentice Hall of India, 2000

MOBILE COMPUTING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Data communication and Computer Networks							
Objective:	• To learn emerging techniques in GSM, wireless MAC. • To learn mobile network and transport layer. • To learn mobile database, data dissemination and MANAT protocols							

CO1	Remember and understand the basic concepts/Principles of mobile computing.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I: INTRODUCTION, GSM, WIRELESS MAC (10 Hours)

Introduction to Mobile Communications and Computing: Mobile Computing (MC): Introduction to MC, novel applications, limitations, and architecture. GSM: Mobile services, System architecture, Radio interface, Protocols, Localization and calling, Handover, Security, and New data services. Wireless Medium Access Control: Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA.

UNIT – II: MOBILE NETWORK AND TRANSPORT LAYER (10Hours)

Mobile Network Layer: Mobile IP (Goals, assumptions, entities and terminology, IP packet delivery, agent advertisement and discovery, registration, tunneling and encapsulation, Optimizations), Dynamic Host Configuration Protocol (DHCP). Mobile Transport Layer : Traditional TCP, Indirect TCP,

Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission, Transaction oriented TCP.

UNIT – III: MOBILE DATABASE AND DATA DISSEMINATION (10 Hours)

Database Issues: Hoarding techniques, caching invalidation mechanisms, client server computing with adaptation, power-aware and context-aware computing, transactional models, query processing, recovery, and quality of service issues. Data Dissemination: Communications asymmetry, classification of new data delivery mechanisms, push-based mechanisms, pull-based mechanisms, hybrid mechanisms, selective tuning (indexing) techniques.

UNIT – IV: MANAT, PROTOCOLS (10 Hours)

Mobile Ad hoc Networks (MANETs): Overview, Properties of a MANET, spectrum of MANET applications, routing and various routing algorithms, security in MANETs.

Protocols and Tools: Wireless Application Protocol-WAP. (Introduction, protocol architecture, and treatment of protocols of all layers), Bluetooth (User scenarios, physical layer, MAC layer, networking, security, link management) and J2ME.

TEXT BOOKS :

11. Jochen Schiller,"MobileCommunications",Addison-Wesley.
12. Stojmenovic and Cacute, "Handbook of Wireless Networks and Mobile Computing"

REFERENCES:

13. Reza Behravanfar, "Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML", ISBN: 0521817331, Cambridge University Press.
14. Adelstein, Frank, Gupta, Sandeep KS, Richard III, Golden, Schwiebert, Loren, "Fundamentals of Mobile and Pervasive Computing", McGraw-Hill Professional.
15. Hansmann, Merk, Nicklous, Stober, "Principles of Mobile Computing", Springer.
16. Martyn Mallick, "Mobile and Wireless Design Essentials", Wiley DreamTech.

CLOUD COMPUTING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Basic Computer Network							
Learning Objective:	• To develop the understanding of fundamentals and technological aspects of Cloud Computing. • Management of cloud services. • Virtualization along with various terminologies and the keywords used in Cloud Computing and virtualization. • Storage network design and optimization.							

CO1	Remember and understand the basic concepts/Principles of cloud computing.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT –I:CLOUD COMPUTING FUNDAMENTALS (10 Hours)

Introduction; Distributed Data Processing, Distributed Database System, Promises of DDBSs, Problem areas. Cloud Computing definition, private, and public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and Challenges to Cloud architecture. Application availability, performance, security and disaster recovery

UNIT –II: MANAGEMENT OF CLOUD SERVICES (08 Hours)

Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment; Cloud Economics: Cloud Computing infrastructures available for implementing cloud based services.

UNIT –III: VIRTUALIZED DATA CENTER ARCHITECTURE & INFORMATION STORAGE SECURITY & DESIGN (12 Hours)

Cloud infrastructures; public, private, hybrid. Service provider interfaces; Saas, Paas, Iaas. VDC environments; concept, planning and design, business continuity and disaster recovery principles. Managing VDC and cloud environments and infrastructures. Storage strategy and governance; security

and regulations. Designing secure solutions; the considerations and implementations involved. Securing storage in virtualized and cloud environments.

UNIT –IV: STORAGE NETWORK DESIGN & OPTIMIZATION OF CLOUD STORAGE

(10 Hours)

Architecture of storage, analysis and planning. Storage network design considerations; NAS and FC SANs, hybrid storage networking technologies (iSCSI, FCIP, FCoE), design for storage virtualization in cloud computing, host system design considerations. Global storage management locations, scalability, operational efficiency. Global storage distribution; terabytes to petabytes and greater

TEXT BOOKS:

1. Greg Schulz, "Cloud and Virtual Data Storage Networking", Auerbach Publications [ISBN: 978-1439851739], 2011.
2. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010.

REFERENCE BOOKS:

1. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A PracticalApproach" McGraw-Hill Osborne Media; 1 edition [ISBN: 0071626948], 2009.
2. Dimitris N. Chorafas, "Cloud Computing Strategies" CRC Press; 1 edition [ISBN: 1439834539], 2010.
3. EMC, "Information Storage and Management" Wiley; 2 edition [ISBN: 9780470294215], 2012.

ADVANCED DATABASE SYSTEMS								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	DBMS, Computer Networks							
Objective:	To know advanced concepts of database in large scale analytics, derive data maintenance, change schema, database update and Benchmark Object Databases, deals with uncertainties in advanced concepts of database, and open issues in database technologies.							

CO1	Remember and understand the basic concepts/Principles of advanced database systems.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT –I: PARALLEL AND DISTRIBUTED DATABASES (08 Hours)

Inter and Intra Query Parallelism – Architecture – Query evaluation – Optimization – Distributed Architecture – Storage – Catalog Management – Query Processing - Transactions – Recovery - Large-scale Data Analytics in the Internet Context – Map Reduce Paradigm - run-time system for supporting scalable and fault-tolerant execution - paradigms: PigLatin and Hive and parallel databases versus Map Reduce

UNIT –II: ACTIVE DATABASES, TEMPORAL AND OBJECT DATABASES (14 Hours)

Syntax and Semantics (Starburst, Oracle, DB2) – Taxonomy – Applications – Integrity Management – Workflow Management – Business Rules – Design Principles – Properties – Rule Modularization – Rule Debugging – IDEA methodology – Open Problems.

Overview – Data types – Associating Facts – Temporal Query Language – TSQL2 – Time Ontology – Language Constructs – Architecture – Temporal Support – Object Database and Change Management – Change of Schema – Implementing Database Updates in O2 – Benchmark Database Updates – Performance Evaluation.

UNIT –III: SPATIAL, TEXT AND MULTIMEDIA DATABASES (08 Hours)

Traditional Indexing Methods (Secondary Keys, Spatial Access Methods) – Text Retrieval – Multimedia Indexing – 1D Time Series – 2d Color images – Sub pattern Matching – Open Issues – Uncertainties

UNIT –IV: COMPLEX QUERIES AND REASONING (10 Hours)

Logic of Query Languages – Relational Calculi – Recursive rules – Syntax and semantics of Data log – Fix point semantics – Implementation Rules and Recursion – Rule rewriting methods – Compilation and Optimization – Recursive Queries in SQL – Open issues.

Introduction to Big data analytics and No-SQL

TEXT / REFERENCE BOOKS:

1. Ramakrishnan, Gehrke, "Database Management System", Tata McGraw Hill Publications, Third Edition.
2. Carlo Zaniolo, Stefano Ceri "Advanced Database Systems", Morgan Kauffmann Publishers.
3. VLDB Journal.
4. Elmaski&Navathe -Fundamentals of Database Systems, 4th Edition, Pearson Education
5. Database Systems, Thomas Connolly, Carolyn Begg
6. Raghu Ramakrishnan, "Database Management Systems", Third Edition, McGraw Hill, 2002.

WEB REFERENCES

1. http://video.google.com
2. http://www.blinkvid.com/video
3. http://www.learnerstv.com/course.php?cat=Computers
4. http://www.crazyengineers.com/forum

ADVANCED COMPUTER ARCHITECTURE								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Compute Architecture and Organisation							
Objective:	• To identify the key components of a computing system • To model the parallel programming paradigm							

CO1	Remember and understand the basic concepts/Principles of advanced computer architecture.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT I: INTRODUCTION TO PARALLEL PROCESSING (10 hours)

Trends towards parallel processing, parallel processing mechanisms. Multicomputer and multiprocessor system, Flynn's classification. Parallel Computer Structures: Pipeline computers, Shared Memory Architecture: UMA, NUMA, loosely coupled multiprocessors, tightly coupled multiprocessors, PRAM model.

UNIT II:PIPELINING AND SUPERSCALAR TECHNIQUE (10 hours)

Pipelining: Basic Concepts of pipelining, data hazards, control hazards and structural hazards.Techniques for overcoming or reducing the effects of various hazards, Speedup, efficiency, throughput.Scheduling- Static scheduling-loop unrolling, Dynamic Scheduling- Scoreboard and Tomasulo's Approach

UNIT III:INSTRUCTION-LEVEL PARALLELISM (10 hours)

Concepts of instruction-level parallelism (ILP), techniques for increasing ILP, superscalar, super-pipelined and VLIW processor architectures, array processor, vector processor, symbolic processors, Associative Processor, Systolic architecture. Amdahl's Law, Scalability-Isoefficiency function, Rule of Thumb.

UNIT IV: INTERCONNECTION NETWORKS AND CACHE ORGINISATION (10 hours)

Definition of Network Topologies, Classification - Static Networks, , Dynamic Networks. Bus, Mesh, Shuffle-Exchange, Omega, Cube, Hypercube.Factors affecting performance of interconnection network. Cache memory organization- Principle of locality, cache mapping, types of cache miss. Techniques to reduce cache miss. Multilevel cache, cache coherence and synchronization mechanism. Cache write policy.

TEXT BOOKS:

17. Kai Hwang and Faye A. Briggs, Computer Architecture and Parallel Processing, 1990.
18. John L. Hennessey and David A. Patterson, Computer Architecture: A Quantitative Approach, 3/e, Morgan Kaufmann, 2003.

REFERENCE BOOKS

19. David A. Patterson and John L. Hennessy, Computer Organization and Design, Elsevier.

20. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill.
21. Computer Architecture: Parhami, Oxford University Press

PARALLEL AND DISTRIBUTED COMPUTING

Course Code		L-P-T-Cr.:	4	0	0	4	Semester:	I
Category:	Programme Elective Course							
Prerequisite:	Fundamentals of computer science.							
Learning Objective:	The objective is to familiarize students with the fundamental concepts, techniques and tools of parallel computing.							

CO1	Remember and understand the basic concepts/Principles of parallel and distributed computing.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I: INTRODUCTION (12 Hours)

Introduction: What is parallel and distributed computing, Scope of parallel and distributed computing, Scope of parallel computing. Parallel Programming Platforms: implicit parallelism, Dichotomy of parallel computing platforms, Physical organization for parallel platforms, communication cost in parallel machines, routing mechanism for interconnection networks.

UNIT – II: BASIC COMMUNICATION OPERATIONS (12 Hours)

Basic Communication Operation: One-to-all broadcast; All-to-all broadcast; Reduction and prefix sums; One-to-all personalized communication; All-to-all personalized communication.

UNIT – III: PERFORMANCE AND SCALABILITY (12 Hours)

Performance and Scalability of Parallel Systems: Performance matrices for Parallel systems. Run time, Speed up, Efficiency and Cost; The effect of granularity on performance. Sorting: Sorting networks; Bubble sort and its variants; Quicksort and other sorting Algorithms.

UNIT – IV: DYNAMIC PROGRAMMING (12 Hours)

Dynamic Programming: Overview of dynamic programming, Serial monadic DP. Formulations: The shortest path Problem, the 0/1 Knapsack Problem, Serial Polyadic DP. Formulation : all pair shortest paths algorithm

TEXT BOOKS:

22. Vipin Kumar, AnanthGrama, Anshul Gupta and George Karypis; Introduction to Parallel Computing, The Benjamin/Cumming Publishing Company, Inc.,Masschachusetts.

REFERENCE BOOKS:

23. George Coulouris, Jean Dollimore and Tim Kindberg; Distributed Systems Concepts andDesign, Addison-Wesley, Masschachusetts.
24. S G Akl; The Decision and analysis of parallel algorithms, PH Englewood Cliffs,New Jersey.
25. Advanced Computer Architecture: Parallelism, Scalability, Programmability, TMH.
26. J Jaja; An Introduction to Parallel Algorithms, Addison Wesley, Masschachusetts
27. T G Lewis and H E Rewini; Introduction to Parallel Computing, Prentice-Hall, Englewood Cliffs, New Jersey.
28. M J Quinn; Parallel Computing: Theory and Practice, McGraw-Hill, New York

HIGH PERFORMANCE COMPUTING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Computer Architecture, Advanced Computer Architecture, OS							

Learning Objective:	The course highlights different features of High-Performance Computing, and how they can be implemented through the hardware (architectural features) and system software (operating systems, run-time systems).

CO1	Remember and understand the basic concepts/Principles of high performance computing.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I: Basics of High Performance Computing (10 hours)
RISC processors, Characteristics of RISC processors, RISC vs. CISC, Classification of instruction set architectures, Review of performance measurements, Basic parallel processing techniques: instruction level, thread level and process level.Need of high speed computing – increase the speed of computers – history of parallel computers and recent parallel computers; solving problems in parallel – temporal parallelism – data parallelism – comparison of temporal and data parallel processing – data parallel processing with specialized processors – inter-task dependency. The need for parallel computers - models of computation - analyzing algorithms – expressing algorithms.

UNIT-II: Pipelining Concepts (10 hours)
Principles of pipelining and vector processing - Linear pipelining - Classification of pipeline processors - General pipelines - Instruction and Arithmetic pipelines –Design of Pipelined instruction unit-Principles of Designing Pipeline Processors- Instruction prefetch and branch handling- Data Buffering and Busing Structure-Internal forwarding and register tagging, Hazard detection and Resolution, Dynamic pipelines and Reconfigurability

UNIT-III: Introduction To Dataflow And Multi-Processor Systems (10 hours) Dataflow computers - Data driven computing and Languages, Data flow computers architectures - Static data flow computer, Dynamic data flow computer, Data flow design alternatives.Multi-Processors: Centralized vs. distributed shared memory, Interconnection topologies, Multiprocessor architecture, Symmetric multiprocessors, Cache coherence problem, memory consistency, Multicore architecture

UNIT-IV: Concepts Of Memories And Process Management (14 hours) Virtual memory: Use of memory by programs, Address translation, Paging, Cache memory: Organization, impact on programming.Operating systems: Processes and system calls, Process management, Program profiling, File systems: Disk management, Name management, Protection, Parallel architecture: Inter-process communication, Synchronization, Mutual exclusion, Basics of parallel architecture, Parallel programming with message passing using MPI.

TEXT BOOK:
1. Hennessey and Patterson, “Computer Architecture: A Quantitative Approach”, Morgan Kaufman.2004.

REFERENCE BOOK
1. K. Hwang, F. A. Briggs, “Computer architecture and parallel processing”, McGraw-Hill.

BIG DATA ANALYTICS								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Basic Computer Network, Cloud Computing and Database system.							
Objective:	• Fundamentals of Big data • Fundamental of Mapreduce • InformationManagement and Data Privacy and Ethics							

CO1	Remember and understand the basic concepts/Principles of big data analytics.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I: **08 hours**

Introduction: Big data and its importance, a flood of mythic "start up" proportions, big data is more than merely big why now? A convergence of key trends, a wider variety of data, the expanding universe of unstructured data, industry examples of big data: Digital marketing and the online world, the right approach, cross channel lifecycle marketing.

UNIT – II: **12 hours**

Big Data Technology: The elephant in the room: Hadoop's parallel world, old vs. new approaches. Data discovery: Work the way people's minds work, open source technology for big data analytics, the cloud and big data, predictive analytics moves into the limelight, a brief history of hadoop, apache hadoop and the hadoop ecosystem.

MapReduce: Analyzing the data with hadoop, map and reduce, java mapreduce, scaling out, data flow, combiner functions, running a distributed mapreduce job, hadoop streaming, the hadoop distributed file system, the design of HDFS, HDFS concepts, blocks, name nodes and data nodes, HDFS federation, HDFS high, availability, the command, line interface, basic file system operations, hadoop file systems.

UNIT – III: **12 hours**

Information Management: The big data foundation, big data computing platforms, big data computation, more on big data storage, big data computational limitations, big data emerging technologies. Business analytics: The last mile in data analysis, geospatial intelligence will make your life better, consumption of analytics, from creation to consumption. Visualizing: How to make it consumable? Organizations are using data visualization as a way to take immediate action.

UNIT – IV: **10 hours**

Data Privacy and Ethics :The privacy landscape, the great data grabisn't new, preferencess, personalization, and relationships, rights andresponsibility, playing in a global sandbox , conscientious and conscious responsibility, privacy may be the wrong focus can data be anonymized? balancing for counter intelligence.

TEXT BOOKS

1. MichaelMinelli, Michele Chambers, Big Data,Big Analytics, Wiley Publications, 2013
2. Tom White, Hadoop: The Definitive Guide, 3/e, O'Reilly Publications, 2012.

REFERENCE BOOKS:

1. Bill Franks Taming, The Big Data Tidal Wave, 1/e, Wiley, 2012.
2. Frank J. Ohlhorst, Big Data Analytics, 1/e, Wiley, 2012

Other References: (Web)

- https://onlinecourses.nptel.ac.in/noc15_mg05/preview
- https://wr.informatik.uni-hamburg.de/_media/teaching/wintersemester_2015_2016/bd-1516-einfuehrung.pdf

INTERNET OF THINGS								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Basic Computer Network							
Objective:	• To Understand the Architectural Overview of IoT. • Understand the vision of IoT from a global context. • Understand the application of IoT. • Determine the Market perspective of IoT.							

CO1	Remember and understand the basic concepts/Principles of internet of things.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I INTRODUCTION (10 Hours)

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.

(10 Hours)

UNIT-II IOT ARCHITECTURE

IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoTarchitecture outline, standards considerations. M2M and IoT Technology. Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business Processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT-III IOT LAYERS PROTOCOLS (10 Hours)

PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT.

UNIT-IV INTERNET OF THINGS PRIVACY, SECURITY AND GOVERNANCE (12 Hours)

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 Smart Cities, Security.

TEXT BOOKS:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1stEdition, Academic Press, 2014.
2. VijayMadisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.

REFERENCE BOOKS:

1. Peter Waher, “Learning Internet of Things”, PACKT publishing,BIRMINGHAM – MUMBAI
2. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet ofThings”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2,Springer

SYSTEM SIMULATION MODELING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Fundamental of computer science and mathematics							
Objective:	• Introduce computer simulation technologies and techniques, provides the foundations for the student to libraries and programs. • This course focuses what is needed to build simulation software environments and not just building simulations using preexisting packages. • Understand computer simulation needs, and to implement and test a variety of simulation and data analysis. • Build tools to view and control simulations and their results.							

CO1	Remember and understand the basic concepts/Principles of system simulation modeling.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I: **(10 Hours)**

System definition and components, System Environment, Stochastic Activities, Continuous and Discrete Systems, System Modeling, Types of models, Static and Dynamic Physical Models, Static and Dynamic Mathematical Models, Principles used in Modeling, System Studies, Types of system study.

UNIT – II: (12 Hours)

System simulation, why & when to simulate, nature and techniques of simulation, Monte Carlo Method, Comparison of simulation and analytical methods, Types of system simulation, Numerical Computation Technique for Continuous Models, Numerical Computation Technique for Discrete Models, Single-server queuing system, Distributed Lag models, Cobweb model, Progress of a Simulation study.

UNIT – III: (12 Hours)

Continuous System Simulation, Analog vs. Digital Simulation, Hybrid Computers, Continuous System Simulation Languages (CSSLs), CSMP-III, Hybrid Simulation, water reservoir system, simulation of an autopilot, Real time Simulation. Discrete system simulation, fixed time-step, generation of random numbers, Simulation of a telephone System, Simulation Programming Tasks, test for randomness, Discrete simulation languages.

UNIT – IV: (14 Hours)

System dynamics, exponential growth models, exponential decay models, modified exponential growth models, logistic curves, generalization of growth models, system dynamic diagrams. Introduction to GPSS, simulation of Manufacture Shop, Gathering Statistics, Data structure in GPPS, Evaluation of Simulation Algorithm in GPSS. Introduction to SIMSCRIPT: Program, system concepts, origination, and statements, defining the telephone system model, Data structure in SIMSCRIPT, Evaluation of Simulation Algorithm in SIMSCRIPT.

TEXT BOOKS:

1. Geoftrey Gordon, " System Simulation",2/e, PHI

REFERENCE BOOKS:

2. Jerry Banks, John S. C Barry L. Nelson David M.Nicol, "Discrete Event System Simulation", Pearson Education.
3. Narsingh Deo, System Simulation with Digital Computer, PHI
4. V P Singh, "System Modeling and simulation", New Age International.
5. Averill M.Law, W.David Kelton, "System Modeling and simulation and Analysis", TMH

COMBINATORIAL OPTIMIZATION								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Fundamental of computer science and mathematics							
Objective:	To introduce students to combinatorial optimization techniques.							

CO1	Remember and understand the basic concepts/Principles of neural networks and deep learning.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I **(12 Hours)**

Combinatorial algorithms for classic discrete optimization problems, Quick Overview of flow problems : Maximum flow, Minimum Cut, Minimum cost flow. Matching theory: Matchings and alternating paths, Tutte-Berge formula, Maximum cardinality matchings: Bipartite matching via flow, Edmond's blossom algorithm.

UNIT-II **(12 Hours)**

Polyhedral Combinatorics: A unifying approach to combinatorial optimization, Basic polyhedral theory. Linear Programming: Quick overview of duality, algorithms for LP, Equivalence of optimization and separation.

UNIT-III **(12 Hours)**

Integer Programming: Totally unimodular matrices (TUM), Total Dual Integrality (TDI), Cutting plane theory, Branch and bound, branch and cut algorithms. Application of linear and integer programming theory to problems.

UNIT-IV **(12 Hours)**

Other techniques for Combinatorial Optimization: Lattice theory and algorithmic geometry of numbers, Semidefinite Optimization, Matroid Theory, Submodular Optimization.

Text Books:

1. The "4-Bill Book": Combinatorial Optimization by Cook, Cunningham, Pulleyblank, Schrijver; 1st edition.
2. Integer Programming by Conforti, Cornuejols, Zambelli. Online access from Springer from within campus.
3. Theory of Linear and Integer Programming by Alexander Schrijver; 1st edition.
4. Geometric Algorithms and Combinatorial Optimization by Grotschel, Lovasz, Schrijver.

NEURAL NETWORKS AND DEEP LEARNING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Fundamental of computer science.							
Objective:	Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.							

CO1	Remember and understand the basic concepts/Principles of neural networks and deep learning.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I **(10 Hours)**

Introduction: Various paradigms of earning problems, Perspectives and Issues in deep learning framework, review of fundamental learning techniques.

UNIT-II **(10 Hours)**

Feed forward neural network: Artificial Neural Network, activation function, multi-layer neural network.

Training Neural Network: Risk minimization, loss function, backpropagation, regularization, model selection, and optimization.

UNIT-III **(14 Hours)**

Deep Learning: Deep Feed Forward network, regularizations, training deep models, dropouts, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network.

Probabilistic Neural Network: Hopfield Net, Boltzman machine, RBMs, Sigmoid net, Autoencoders.

UNIT-IV **(14 Hours)**

Deep Learning research: Object recognition, sparse coding, computer vision, natural language processing.

Deep Learning Tools: Caffe, Theano, Torch.

TEXT BOOKS

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016..
2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.

REFERENCE BOOKS

1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
2. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

PROBABILTY AND STOCHASTIC PROCESS								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Fundamental of computer science and mathematics							
Learning Objective:	To understand probability theory and stochastic models.							

CO1	Remember and understand the basic concepts/Principles of probabilty and stochastic process.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I:

Vector space, Inner product space, norm, Hilbert spaces. Projection theorem. Separable Hilbert spaces and orthonormal bases. Linear functional. Riesz representation theorem. Probability spaces. Random variables and random vectors. Distributions and densities.

UNIT – II:

Statistical independence. Expectations, moments and characteristic functions. Infinite sequences of random variables. Convergence concepts. Laws of large numbers. Radon-Nikodym theorem. Conditional expectations given aσ-field and a random vector. Jensen's inequality.

UNIT – III:

Stochastic processes. Separability and measurability. Continuity concepts. Gaussian Processes and Wiener processes. Second order processes. Covariance functions and their Properties. Linear operations and second order calculus, orthogonal expansions. Stationarity in the strict and wide senses. Ergodicity

in the q.m.sense. Wide sense Stationary processes

UNIT – IV:

Herglotz's and Bochner's theorems. Spectral representation. L2- stochastic integrals.Spectral decomposition theorem. Low-pass and band-pass processes. White noise andWhite-noise integrals

TEXT BOOKS:

1. Papoulis, S. U. Pillai, "Probability, Random variables and Stochastic processes" Tata-Mc Hill
2. R.B.Ash&C.Doleans-Dade, Probability and Measure Theory.

REFERENCE BOOKS:

1. E.Wong&B.Hajek, Stochastic Processes in Engineering systems, Springer, 1985
2. R.B.Ash&W.A.Gardner, Topics in stochastic processes, Academic Press, 1975.
3. Stakgold, I., Green's Functions and Boundary value Problems (e), Wiley, 1998.

NATURAL LANGUAGE PROCESSING								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Artificial Intelligence							
Objective:	• To introduce concepts of learning. • To know decision tree learning and various learning methods.							

CO1	Remember and understand the basic concepts/Principles of natural language processing.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I **(12 Hours)**

Basic Probability & Information Theory: Introduction to NLP, Main Issues, Basics on Probability Theory, Elements of Information Theory, Language Modeling in General and Noisy Channel Model, Smoothing and EM Algorithm.

UNIT-II **(12 Hours)**

Linguistics: Phonology and Morphology, Syntax (Phrase Structure vs. Dependency). Words & Lexicon: Word Classes and Lexicography, Mutual Information, The t-score, The Chi-square Test, Word Classes for NLP Tasks, Parameter Estimation, Partitioning Algorithm, Complexity Issues of Word Classes, Programming Tricks & Tips.

UNIT-III **(12 Hours)**

Hidden Markov Models & Tagging: Markov Models, Hidden Markov Models (HMMs), Trellis Algorithm, Viterbi Algorithm. Estimating the Parameters of HMMs, The Forward-Backward Algorithm, Implementation Issues, Task of Tagging, Tag sets, Morphology, Lemmatization, Tagging

Methods, Manually Designed Rules and Grammars, Statistical Methods, HMM Tagging (Supervised, Unsupervised), Evaluation Methodology (examples from tagging), Precision, Recall, Accuracy, Statistical Transformation Rule-Based Tagging, Maximum Entropy, Maximum Entropy Tagging, Feature Based Tagging, Results on Tagging, Various Natural Languages.

UNIT-IV **(12 Hours)**

Grammars & ParsingAlgorithms: Introduction to Parsing, Generative Grammars, Properties of Regular and Context-free Grammars, Overview on Non-statistical Parsing Algorithms, Simple Top-Down Parser with Backtracking, Shift-Reduce Parser, Tree banks and Tree banking, Evaluation of Parsers, Probabilistic Parsing. PCFG: Best Parse, Probability of String.

Statistical Parsing & Machine Translation: Lexicalized PCFG, Statistical Machine Translation (MT), Alignment and Parameter Estimation for MT.

TEXT BOOK

1. Foundations of Statistical Natural Language Processing, Manning, C. D. and H. Schutze, The MIT Press.

REFERENCE BOOK

2. Speech and Language Processing, Juraf sky, D. and J. H. Martin, Prentice-Hall.
3. Natural Language Understanding, Allen, J., The Benajmins/Cummings Publishing Company Inc.
4. Elements of Information Theory, Cover, T. M. and J. A. Thomas, Wiley.
5. Statistical Language Learning, Charniak, E., The MIT Press.
6. Statistical Methods for Speech Recognition, Jelinek, F., The MIT Press.

COMPUTATIONAL INTELLIGENCE								
Course Code		**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							
Prerequisite:	Mathematics							
Learning Objective:	• To learn different knowledge representation techniques. • To understand the applications of CI: namely Game playing, Theorem Proving. Expert systems, machine learning and Natural language Processing.							

CO1	Remember and understand the basic concepts/Principles of computational intelligence.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I **(10 Hours)**

Introduction to Soft Computing: Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy networks.

UNIT-II **(12 Hours)**

Fuzzy Sets Theory and applications: Introduction, Basic definitions and terminology, Set-theoretic operations, MF Formulation and parameterization, More on fuzzy union, intersection, and complement. Extension principle and fuzzy relations, Fuzzy if-Then rules, Fuzzy reasoning, Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

UNIT-III **(14 Hours)**

Derivative-free optimization: Genetic algorithm, simulated annealing, random search, Downhill simple search. Adaptive Networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule.

UNIT-IV **(14 Hours)**

Neural Networks: Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial Bias Function networks, modular network. Unsupervised learning and other

neural networks: Competitive learning networks, Kohonen self organizing networks, learning vector Quantization, Hebbian learning, principal component networks, and The Hop field network. Reinforcement learning. Adaptive Neuro-Fuzzy Inference Systems: ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize, ANFIS and RBNF, Simulation examples.

TEXT BOOK

1. Neuro Fuzzy and Soft Computing by J. S. R. Jang, C. T. Sun, E. Mizutani, PHI, 1st Edition.
2. Neural Networks and Learning Machines by Simon Haykin, PHI, 3rd Edition.

REFERENCE BOOK

1. Genetic Algorithms in search, Optimization and Machine learning by David E. Goldberg, 1st Edition, PEARSON.

RESEARCH METHODOLOGY								
Course Code	**CS 713**	**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Core Course							
Prerequisite:	None							
Objective:	To inform the students about the basics of how research problems are defined, research methods are adopted and/or developed, research is undertaken, and how research results are communicated to the peers.							

CO1	Remember and understand the basic concepts/Principles of research methodology.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT – I: INTRODUCTION TO RESEARCH METHODOLOGY (12 Hours)

An Introduction, meaning, objectives and purpose of research. Types of research, significance and characteristics of research, criteria of good research, Research Methods and methodology, scientific methods.

UNIT – II: RESEARCH PROBLEMS AND PROCESS (12 Hours)

Research process and problems, Research design, type of research design, importance of Experimental design, limitations of research.

UNIT – III: DATA ANALYSIS (10 Hours)

Data collection, Sources of Data, Methods of Data collection, sample size and sampling, test of reliability and validity, formulation and testing of hypothesis, various parametric and non-parametric tests like ANOVA, MANOVA, multivariate analysis, measures of central tendencies and multiple regression.

UNIT – IV: REPORT PRESENTATION (14 Hours)

Report writing, Structure of scientific report, Types of report, Significance of the report, characteristics of repot, report heading and body of the report, References/Bibliography.

Research evaluation methods, various index (h-index, I-index, etc.) index and abstracting service and their calculations. Plagiarism, its significance and effects. Components of IPR, Patent Laws. Software: LaTex, Matlab, R

REFERENCE BOOKS:

1. Research Methods of Science, Michael M. Marda, CambridgeUniversity Press, New York.
2. Research Methodology, C.C. Kothari &GouravGarg, Third Edition, NewAgeInternational Publication, Delhi.
3. Probability and Error for Physical Science, S.K. Muthu Orient Lougman,
4. Research Methodology, Dr. P.R. Majhi and Dr. P.K. Khatua Himalaya Publication House
5. Methods of social survey research by S R Bajpai, Sage Publication, KitabGhar.

WIRELESS SENSOR NETWORK & APPLICATIONS								
Course Code	**CS 714**	**L-P-T-Cr.:**	**4**	**0**	**0**	**4**	**Semester:**	**I**
Category:	Programme Elective Course							

Prerequisite:	Basic of Computer networks
Learning Objective:	The purpose of this course is to introduce students to • Obtain a broad understanding about the network architecture of wireless sensor network. • Understand all basic characteristics of wireless sensor networks and sensor nodes. • The principles of data transmission, clustering algorithm and routing protocols. • Design and development of new network architecture and MAC protocols. • Understand various application of Wireless Sensor Network

CO1	Remember and understand the basic concepts/Principles of wireless sensor network & applications.
CO2	Analyse the Various Concepts to understand them through case studies.
CO3	Apply the knowledge in understanding practical problems.
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course.

UNIT-I: INTRODUCTION (10 Hours)

Networked wireless sensor devices, Key design challenges. **Network deployment:** Structured versus randomized deployment, Network topology, Connectivity, **Application:** Applications: Habitat Monitoring, Smart Transportation, Detecting unauthorized activity using a sensor network**,** SUltra wide band radio communication, and Wireless fidelity systems. Future directions, Home automation, smart metering Applications.

UNIT-II: LOCALIZATION AND WIRELESS CHARACTERISTICS (10 Hours)

Localization: Issues & approaches, Coarse-grained & Fine-grained node localization, Network-wide localization. **Wireless characteristics:** Basics, Wireless link quality, Radio energy considerations, SINR capture model for interference.

UNIT-III: MEDIUM-ACCESS AND SLEEP SCHEDULING (10 Hours)

Issues in designing MAC protocol for WSNs, Classification of MAC Protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques.

Classification of Energy Management Schemes, Transmission Power Management Schemes, System Power Management Schemes, Energy harvesting for self-sustainable WSNs.

UNIT-IV: ROUTING AND INTEGRATION OF SENSOR & CLOUD SYSTEM (10 Hours)

Routing: Metric-based approaches, Routing with diversity, Multi-path routing, Lifetime-maximizing energy-aware routing techniques, Geographic routing,

Introduction to cloud system,Sensor Cloud Systems, Challenges in Sensor Cloud Systems: Energy Efficiency issues, Storage issues, Design Issues. Classification of energy efficient sensor cloud techniques. Data prediction based energy efficient sensor cloud system.

TEXT BOOKS:

1. Wireless Sensor Networks: Technology, Protocols, and Applications: Kazem Sohraby, Daniel Minoli, Taieb Znati , Wiley Inter Science.
2. Networking Wireless Sensors: BhaskarKrismachari, Cambridge University Press

REFERENCE BOOKS:

1. Wireless Sensor Networks: Architectures and Protocols: Edgar H. Callaway, Jr. Auerbach Publications, CRC Press.
2. Wireless Sensor Networks: Edited by C.S Raghavendra, Krishna M, Sivalingam, TaiebZnati , Springer.
3. Distributed Sensor Networks: A Multiagent Perspective, Victor Lesser, Charles L. Ortiz, and MilindTambe , Kluwer Publications.
4. Wireless Sensor Networks: An Information Processing Approach- by Feng Zhao, Leonidas Guibas , Morgan Kaufmann Series in Networking 2004.

Other References: (Web)

- https://onlinecourses.nptel.ac.in/noc17_cs07/preview
- http://nptel.ac.in/courses/106105160/21