Sanjay Ghodawat University, Kolhapur

School of Technology

Department of Computer Science and Engineering

Structure and Contents for Third Year B. Tech. Computer Science and Engineering Program

(AY 2020-21) R0

AME/P/80/00

Structure for B. Tech Third Year Semester V									
Course Code	**Course Title**	**L**	**T**	**P**	**C**		**Evaluation Scheme**		
						Component	**Exam**	**WT %**	**Min. Pass %**
CST301 (PC | ST) Version: 1.0	Design and Analysis of Algorithms	3	-	-	3	Theory	FET	20	40
							CAT I	15	
							CAT II	15	
							ESE	50	40
CST303 (PC | ST) Version: 1.0	Design and Analysis of Algorithms Laboratory	-	-	2	1	Practical	FEP	100	40
CST305R1 (PC | ST) Version: 1.0	Compiler Design	3	-	-	3	Theory	FET	20	40
							CAT I	15	
							CAT II	15	
							ESE	50	40
CST307R1 (PC | ST) Version: 1.0	Compiler Design Laboratory	-	-	2	1	Practical	FEP	50	40
							OE	50	40
CST309 (PC | ST) Version: 1.0	Information Security	3	-	-	3	Theory	FET	20	40
							CAT I	15	
							CAT II	15	
							ESE	50	40
CST311 (PC | ST) Version: 1.0	Information Security Laboratory	-	-	2	1	Practical	FEP	50	40
							POE	50	40
CST313._ (PE | ST) Version: 1.0	Program Vertical I	3	-	-	3	Theory	FET	20	40
							CAT I	15	
							CAT II	15	
							ESE	50	40
CST315._ (PE | ST) Version: 1.0	Program Vertical I Laboratory	-	-	2	1	Practical	FEP	100	40
CST317 (PC|ST) Version: 1.0	Software Proficiency Program I	-	-	4	2	Practical	FEP	50	40
							POE	50	40
CST319 (MC) Version: 1.0	Scholastic Aptitude	3	-	-	Au	Theory	FET	100	40
Total		**15**		**12**	**18**	**Total Hours: 27, Total Credits: 18**			

FET – Faculty Evaluation Theory; FEP - Faculty Evaluation Practical; CAT – Continuous Assessment Test; ESE – End Semester Examination; Au - Audit Course

Sanjay Ghodawat University, Kolhapur

School of Technology

Department of Computer Science and Engineering

Structure and Contents for Third Year B. Tech. Computer Science and Engineering Program

(AY 2020-21) R0

AME/P/80/00

Structure for B. Tech Third Year Semester VI									
Course Code	**Course Title**	**L**	**T**	**P**	**C**		**Evaluation Scheme**		
						Component	**Exam**	**WT %**	**Min. Pass %**
CST302 (PC | ST) Version: 1.0	Computer Organization And Architecture	3	-	-	3	Theory	FET	20	40
							CAT I	15	
							CAT II	15	
							ESE	50	40
CST304 (PC | ST) Version: 1.0	Computer Organization And Architecture Laboratory	-	-	2	1	Practical	FEP	100	40
CST306 (PC | ST) Version: 1.0	Advanced Database Systems	3	-	-	3	Theory	FET	20	40
							CAT I	15	
							CAT II	15	
							ESE	50	40
CST308 (PC | ST) Version: 1.0	Advanced Database Systems Laboratory	-	-	2	1	Practical	FEP	50	40
							POE	50	40
CST310 (PC | ST) Version: 1.0	Machine Learning	3	-	-	3	Theory	FET	20	40
							CAT I	15	
							CAT II	15	
							ESE	50	40
CST312 (PC | ST) Version: 1.0	Machine Learning Laboratory	-	-	2	1	Practical	FEP	50	40
							POE	50	40
CST314._ (PE | ST) Version: 1.0	Program Vertical II	3	-	-	3	Theory	FET	20	40
							CAT I	15	
							CAT II	15	
							ESE	50	40
CST316._ (PE | ST) Version: 1.0	Program Vertical II Laboratory	-	-	2	1	Practical	FEP	100	40
CST318 (PC|ST) Version: 1.0	Software Proficiency Program II	-	-	4	2	Practical	FEP	50	40
							POE	50	40
CST320 (PW|ST) Version: 1.0	Mini Project	-	-	2	1	Practical	FEP	50	40
							POE	50	40
CST322 (PW|ST) Version: 1.0	Internship Training	-	-	-	1	Project	FEP	100	40
CST324 (MC) Version: 1.0	Foreign Language	2	-	-	Au	Theory	FET	100	40
Total		**14**		**14**	**20**	**Total Hours: 28, Total Credits: 20**			

Internship Training

Students are required to undergo internship of ***three*** **weeks** during vacation at the end of semester V and the same will be evaluated in semester VI.

Professional Core Courses

1. Design and Analysis of Algorithms	4. Computer Organization And Architecture	7. Distributed and parallel computing
2. System Programming & Compiler Design	5. Advanced Database Systems	8. Agile Software Development
3. Information Security	6. Machine Learning	9. Mobile Application Development

Program Verticals

Verticals are to be decided by the students based on his personal choice, academic requirements and in consultation with mentor and HOD. Following verticals are offered by the department:

	(Vertical 1) **Networking**	**(Vertical 2)** **Artificial Intelligence**	**(Vertical 3)** **Applications**	**(Vertical 4)** **Information Security**
Program Vertical I (for Semester V) **CST313._**	1. Wireless Sensor Network	3.Data Mining and Warehousing	5.Simulation and Modeling	7. Cyber Security
	2.Mobile Computing	4. Business Analytics	6.Computer Vision	8. Digital Forensics
Program Vertical II (for Semester VI) **CST314._**	1. Advanced Network Technologies	3. Intelligent Systems	5.High Performance Computing	7. Ethical Hacking
	2.Internet of Things	4. Recommender Systems	6.Human-Computer Interaction	8. Risk Assessment and Security Audit

Sanjay Ghodawat University, Kolhapur

School of Technology

Department of Computer Science and Engineering

Structure and Contents for Third Year B. Tech. Computer Science and Engineering Program

(AY 2020-21) R0 AME/P/80/00

Minor and Honors for undergraduate Program (B. Tech.)
Offered by Department of Computer Science and Engineering

Minor Programs

Minor Programs are designed by department of Computer Science and Engineering and offered to students from other departments who have the capability to earn additional 16 credits over and above the credits specified for the Program. The student should have obtained minimum CGPA of 7.0 without any backlogs at the end of fourth semester. The student is required to pay an additional tuition fee as specified and examination fee for the courses opted and there is no reexamination for these courses. The student is required to earn specified credits for the course in first attempt only. No repeat examinations and any failure may lead to opting out from the minor program.

Credit structure of the Minor programs offered by

Department of Computer Science and Engineering

Semester	Course Code	Course name	L	T	P	Credits
Semester V	CST321	Data Structures and Algorithms	3	1	-	04
Semester VI	CST326	Programming in Python	3	-	-	04
	CST328	Programming in Python Laboratory	-	-	2	
Semester VII	CST419	Web Development	3	-	-	04
	CST421	Web Development Laboratory	-	-	2	
Semester VIII	CST410	Minor Project	-	-	-	04
Total Credits						16

Honors Program

A student from Department of Computer Science and Engineering can opt for honors degree in his/her own program of study leading to B. Tech. Honors. The student has two options to earn the 16 credits:

1. **Registering and completing minimum 6 online MOOCs (massive open online courses)** specific to Computer Science and Engineering program offered by NPTEL, SWAYAM/ any other web based courses approved by the department during the program of study. For credits of these MOOC courses, the students are informed to consult department MOOC coordinator.

2. **Opting for dual mode**: Contact and online combination. In this case minimum 2 courses are to be web based and the student can opt for other courses from M.Tech (CSE) Programme as shown below:

Semester	Course name	Credits to be earned
Semester V	*Course 1	4
Semester VI	*Course 2	4
Semester VII	*Course 3	4

*Courses from M.Tech (CSE) Programme

MOOC Courses

As per the scheme of Sanjay Ghodawat University, from semester V to semester VIII, every semester the students need to undergo a certification which will have 4 credits. Students will earn 16 credits through this scheme and expose themselves to new courses of their interest and in the process develop their self learning skills.

Computer Science and Engineering department has identified MOOC courses from NPTEL which can be opted by students. The list of shortlisted courses will be communicated to the students from time to time. However, the MOOC courses are not restricted to NPTEL alone. Any standard MOOC course offered by a recognized organization which is worth 4 credits, can be opted by the students.

CST301 : Design and Analysis of Algorithms							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Data Structures

Course Outcomes: After the end of this course students will be able to

CO1 **Solve**[3] real time problems based on different algorithmic statergies
CO2 **Analyse**[4] the complexity of different algorithms based on different techniques
CO3 **Classify**[4] real time problems into different algorithmic techniques
CO4 **Compare**[4] different algorithms based on different techniques

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction to Algorithms:** Introduction to Algorithm, Growth of Functions-Solving Recursive Equation: Substitution method, Iteration Method and Master Method. Divide and Conquer: Finding maximum and Minimum, Selection, Stassen's matrix Multiplication.	7
II.	**Greedy Algorithms :** Greedy Approach-General Method, Knapsack Problem, Minimum cost spanning tree- Prim's and Kruskal's algorithm, Single Source Shortest Path.	7
III.	**Dynamic Programming :** Principle of Optimality, All Pair Shortest Path, longest Common Sequence, Optimal binary search algorithm, Travelling	7

Salesman Problem, Reliability Design.

IV.	**Backtracking:** General Method, 8-Queen Problem, Sum-of-Subnet Problem, Hamilton Cycle, Branch and Bound Knapsack Problem, Travelling Salesman Problem.	**7**
V.	**String Matching And Parallel Algorithm :**Simple String matching, The naive string-matching algorithm, The Rabin-Karp algorithm, PRAM Computation Model, Fundamental techniques, MESH-Computation model, Packet Routing, Fundamental techniques, HYPERCUBE-Computation model, PPR Routing, Fundamental techniques.	**7**
VI.	**NP-Hard and NP-Complete Problems :** Basic concept of N, NP, NP-Hard, NP-Complete, NP-Hard Graph Problems-Clique Decision Problem(CDP), Node Cover Decision Problem (NCDP), Chromatic number decision problem (CNDP), Directed Hamiltonian Cycle (DHC), Traveling salesman Problem (TSP), AND/OR Graph decision Problem (AOG).	**7**

Textbooks:

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, “Fundamentals of Computer Algorithms”, Second Edition, Universities Press, Hyderabad, 2008.
2. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, “Introduction to Algorithms”, Second Edition, Prentice Hall of India, New Delhi, 2007.

References :

1. Kenneth A. Berman and Jerome L. Paul, “Algorithms”, Cengage learning India Edition, New Delhi, 2002.
2. Sara Baase and Allen Van Gelder, “Computer Algorithms – Introduction to Design & Analysis”, Third Edition, Pearson Education, New Delhi, 2000.

CST303 : Design and Analysis of Algorithms Laboratory							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Data Structures

Course Outcomes: After the end of this course students will be able to

CO1 **Find**[4] complexity of given algorithm by using recurrence relations.

CO2 **Solve**[3] different real time problems based on different algorithmic strategy.

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Write programs based on recursive algorithms.
2. Write program for selection problem.
3. Write program to implement Knapsack problem using greedy technique.
4. Write program to implement Prim's/Kruskal's algorithm.
5. Write program to implement Single-Source Shortest Path.
6. Write program to implement All- Pair Shortest Path.
7. Write program to implement Travelling Salesman problem.
8. Write program to implement 8-Queens problem.
9. Write program to implement Hamiltonian cycle problem.
10. Write program to implement Knapsack using Branch and Bound technique.
11. Write program to implement Naive string-matching algorithm.
12. Write program to implement the Rabin-Karp algorithm.
13. Write program to implement List ranking in PRAM.
14. Write program to implement Prefix Computation in MESH.

Textbooks:

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, Hyderabad, 2008.
2. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, "Introduction to Algorithms", Second Edition, Prentice Hall of India, New Delhi, 2007.

References :

1. Kenneth A. Berman and Jerome L. Paul, "Algorithms", Cengage learning India Edition, New Delhi, 2002.
2. Sara Baase and Allen Van Gelder, Computer Algorithms – "Introduction to Design & Analysis", Third Edition, Pearson Education, New Delhi, 2000.

CST305R1: Compiler Design Ver 1.0, Program Core, School of Technology							
Lect.	**Tut.**	**Pract.**	**Credits**	**Evaluation Scheme**			
				Component	**Exam**	**Weightage %**	**Pass %**
3	-	-	3	Theory 100 Marks	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Basics of programming in C, Compilation of expressions and control structures. Fundamentals of Theory of Computation: Finite Automata and its types, context free grammar, derivations / parsing of a string, ambiguity of grammar, basics of parsing and types of parsers.

Course Outcomes: After the end of this course students will be able to

CO1 **Describe**[2] generation of tokens during the compilation process.

CO2 **Apply**[3] parsing techniques to parse a string

CO3 **Simplify**[4] generation of intermediate code using semantic analysis

CO4 **Apply**[3] different code generation techniques to optimize the code.

Syllabus (Theory)

Unit	Description	Hrs
I	**Introduction** Introduction to language processors software's,, Evolution of Compilers, the structure of a Compiler, Language Design and Compilers, Applications of Compiler Technology.	3
II	**Lexical Analysis** Role of Lexical Analyzer, Lexical Errors, Input Buffering, Sentinels, Specification of Tokens, Recognition of Tokens.	3
III	**Syntax Analysis and Role of Parsers** Role of Parser, Writing CFG for expressions and control structures, Eliminating Dangling – Else Ambiguity, Elimination of Left Recursion and Left Factoring. **Top Down Parser –** Top Down Parser**,**LL(1) Class of Grammar and Types of Parsers - Recursive Descent Parser with Backtracking, Calculating First and Follow, Predictive Parser, Error Recovery in Predictive Parsing.	10

IV	**LR Parsers** **Bottom-Up Parsing –** Bottom up parsing**,** Handle, Handle Pruning, Shift- Reduce Parsing, Conflicts in Shift – Reduce Parsing, Types LR Parsers **–** Need of LR Parser, LR(0) Items, Augmented grammar, Kernel Items, Viable Prefixes , Closure and Goto function, Canonical Construction of LR (0) Items, Construction of LR(0) & SLR Parsing **t**able and parsing of string, LR(1) Items and Canonical Construction of LR(1) Items, Construction of more powerful parsers –LALR, Canonical LR Parsing Tables and parsing of string.	**10**
V	**Semantic Analysis and Intermediate Code Generation** Syntax – Directed Definition – Semantics, Attributes and Attributed Grammar, Types of Attributes, Writing Syntax Directed Definition & Annotated Tree, Construction of syntax tree, Dependency Graphs, S- Attributed Definition, L-Attributed Definition, Application of Syntax Directed Translation, Converting SDD to SDT, Back- patching.	**8**
VI	**Code Optimization& Code Generation** Representation of intermediate code using Three – Address Code, Quadruples, Triples, Indirect Triples, Processing of Assignment Statement, Translation of Expression, Principle Sources of Optimization, Control Flow Graphs - Basic Blocks and Flow Graphs, Loops in Flow Graphs , Peephole optimization, Data Flow Analysis and Equation of Data Flow Analysis , Issues in design of a code generator.	**8**

Textbooks:

1. A.V. Aho, R. Shethi and J.D. Ullman,"Compilers - Principles, Techniques and Tools", Pearson Education

References:

1. D.M. Dhamdare, "Compiler Construction" , Mc-Millan Publication, 2nd Edition.
2. D.M. Dhamdhere, "System Programming and Operating Systems", Tata McGraw Hill Publication, 2nd Edition.

CST307R1 : Compiler Design Laboratory							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	50	40
					OE	50	40

Prerequisite: Basic knowledge of C and C++ programming languages and use of Data structure.

Course Outcomes: After the end of this course students will be able to
CO1 Demonstrate3 different parsing techniques to parse a string
CO2 Apply3 different techniques to optimize the code
CO3 Use3 different techniques to optimize the code

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Remove white spaces (space, tab) and comments from the C/ C++ Program.
2. Implement a program to construct a Symbol Table for the tokens.
3. Demonstrate the working of Lex Tool used in Lexical Analyzer.
4. Implement a program to eliminate left recursion and Left factor of the given input grammar to remove the ambiguity.
5. Implement a program to apply First and Follow functions of LL(1) class of a grammar.
6. Implement a program to demonstrate the working of Top Down parsers.
7. Implement a program to demonstrate the working of LR(0) or SLR
8. Implement a program to demonstrate working of LALR or Canonical LR.
9. Demonstrate the working of Yacc Tool used in Syntax Analyzer.
10. Implement a three address code generator program for the given expression.
11. Implement a program to construct DAG (Directed Acyclic Graph) for expressions
12. Implement a program to construct DAG (Directed Acyclic Graph) for basic blocks.
13. Implement a program to identify the Basic blocks, and loops in a given three address code .

Textbooks:

1. Compilers – principles, Techniques and Tools – A. V Aho, R. Shethi and J. D. Ullman (Pearson Education.)
2. Crafting A Compiler with C - Charles Fischer, Richard LeBlanc (Pearson publication)

References :

1. Modern Compiler Design - D. Grune , H. Bal , C. Jacobs , K. Langendoen , Wiley publication, 2nd Edition.
2. Modern Compiler Implementation in Java - Andrew W. Appel , Cambridge University Press 1998, 2nd Edition.
3. Compiler Construction by D.M. Dhamdare, Mc-Millan Publication, 2nd Edition.

CST309 : Information Security							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Computer Network fundamentals

Course Outcomes: After the end of this course students will be able to

CO1 **Illustrate**[2] **s**ymmetric and asymmetric cryptographic algorithms

CO2 **Demonstrate**[2] Message Authentication Methods

CO3 **Examine**[4] Key Management, Distribution Techniques

CO4 **Determine**[5] the need for security services at the transport, application layers

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:** Security goals, Cryptographic Attacks, Services and Mechanism, technique Mathematics of Cryptography: Integer Arithmetic, Modular Arithmetic, Matrices Traditional. Symmetric-Key Ciphers: Introduction, Substitution Ciphers, Transposition Ciphers, Stream and Block Ciphers.	7
II.	**Data Encryption Standard** Introduction, DES Structure, DES Analysis, Security of DES, IDEA Advanced Encryption Standard: Introduction, Transformations, Key Expansion, and Analysis of AES.	7

III.	**Mathematics of Asymmetric Key Cryptography**	**7**
	Primes, Primality testing, Factorization, Chinese remainder theorem, Asymmetric key cryptography: RSA Cryptosystem, Rabin Cryptosystem.	
IV.	**Message authentication**	**7**
	Message authentication and Hash functions- Authentication functions,MACs, HMAC, CMAC, Hash functions, Digital signatures and authentication protocols, Digital signature standard, Digital Signature Standard. Authentication Applications - Kerberos, X.509 Authentication Service, Public - Key Infrastructure.	
V.	**Key management:**	**7**
	Symmetric Key Distribution, Kerberos, Symmetric Key Agreement, **Security at the Application Layer**: Email, PGP: scenarios, key rings, PGP certificate, Trust model in PGP, PGP Packet, PGP Messages ,S/MIME:MIME,S/MIME	
VI.	**Security at the Transport Layer**	**7**
	SSL Architecture, Services, Key Exchange Algorithm, Encryption/Decryption Algorithm, Hash Algorithm SSL Message Formats, Security At the Network Layer: Two Modes, Two Security Protocol and ISAKMP	

Textbooks:

1. Behrouz A. Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", 2nd Edition, McGraw Hill Education, 2014

References :

1. William Stallings, “Cryptography and Network Security: Principles and Practice”, 5th Edition , Prentice Hall 2013
2. V.S. Bagad and I.A. Dhotre, “Cryptography and Network Security”, Technical Publications 2012

CST311 : Information Security Laboratory							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	50	40
					POE	50	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will able to

CO1 Assess[5] basic cryptographic algorithms
CO2 Demonstarte[3] standard security algorithm

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Implementation of Substitution Cipher
2. Implementation of Polyalphabetic Cipher (Vigenere Cipher and Vernam Cipher)
3. Implementation of Transposition Cipher
4. Implementation of Playfair Cipher
5. Implementation of DES algorithm
6. Implementation of AES algorithm
7. Implementation of Secure file transfer in Client/Server environment (use any one of above method for encryption and decryption)
8. Write a program to simulate RSA algorithm
9. Write a program to simulate any Authentication system.
10. Write a program to simulate the PGP.
11. Implementation the working Process of Kerberos
12. Implementation of Hash function

Textbooks:

1. Behrouz A. Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security" 2nd Edition, McGraw Hill Education, 2014

References :

1. William Stallings, "Cryptography and Network Security: Principles and Practice" 5th Edition, Prentice Hall 2013.
2. V.S. Bagad and I. A. Dhotre, "Cryptography and Network Security", Technical Publications 2012.

CST313.1 : Wireless Sensor Network							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Computer Networking, Wireless Adhoc Networks

Course Outcomes: After the end of this course students will be able to

CO1 **Describe**[2] basic concept of WSNs, supportive technologies and radio transmission issues

CO2 **Compare**[4] requirements of access control protocols and media access control techniques

CO3 **Describe**[2] different strategies used to develop routing protocols for WSN

CO4 **Classify**[2] operating systems for wireless sensor networks and design

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction and Overview of Wireless Sensor Networks:** Introduction, Basic Overview of the Technology, Applications of Wireless Sensor Networks, Another Taxonomy of WSN Technology	7
II.	**Basic Wireless Sensor Technology:** Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating environment, , Wireless Transmission Technology and Systems, Radio Technology Primer, Available Wireless Technologies, Medium Access Control Protocols for Wireless Sensor Networks	7
III	**Routing Protocols for Wireless Sensor Networks:** Data Dissemination and Gathering, Routing Challenges and Design Issues	7

	in Wireless Sensor Networks, Routing Strategies ,Transport Control Protocols for Wireless Sensor Networks, Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols	
IV.	**WSN Middleware Principles:**	
	Middleware Architecture, Network Management for Wireless Sensor Networks, Network Management Requirements, Traditional Network Management Models, Network Management Design Issues, Example of Management Architecture: MANNA	**7**
V.	**Operating Systems for Wireless Sensor Networks:**	
	Operating System Design Issues, Examples of Operating Systems, TinyOS, Mate, MagnetOS, MANTIS, OSPM,EYES OS, SenOS, EMERALDS, PicOS	**7**
VI.	**Performance and Traffic Management:**	
	Introduction, Background, WSN Design Issues, MAC Protocols, Routing Protocols, Transport Protocols, Performance Modeling of WSNs, Performance Metrics, Basic Models, Network Models, Case Study: Simple Computation of the System Life Span	**7**

Textbooks:

1. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks, Theory and Practice”, 1st Edition, John Wiley & Sons, 2007.

2. Kazem Sohraby, Daniel Manoli “Wireless Sensor Networks- Technology, Protocols and Applications”, 1st Edition ,Wiley InterScience Publications, 2010.

References :

1. Bhaskar Krishnamachari, "Networking Wireless Sensors”, 1st Edition, Cambridge University Press, 2005

2. C.S Raghavendra, Krishna M.Sivalingam, Taieb znati, ”Wireless Sensor Networks”, 1st Edition, Springer Science, 2004

3. Edgar H. Callaway, Jr. and Edgar H. Callaway, ”Wireless Sensor Networks: Architectures and Protocols”, 1st Edition, CRC Press, 2003.

CST313.2 : Mobile Computing							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Network technologies

Course Outcomes: After the end of this course students will be able to

CO1 **Illustrate**[2] the basics concept of mobile telecommunication systems

CO2 **Identify**[3] the generations of telecommunication systems in wireless networks

CO3 **Categorize**[4] the functionality of MAC, network layer, Transport and Application layers

CO4 **Construct**[3] a mobile application using Android/blackberry/ios/Windows SDK

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:** Introduction to Mobile Computing – Applications of Mobile Computing- Generations of Mobile Communication Technologies- Multiplexing – Spread spectrum -MAC Protocols – SDMA- TDMA- FDMA- CDMA	7
II.	**Mobile Telecommunication and system:** Introduction to Cellular Systems – GSM – Services & Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Mobility Management – Security – GPRS- UMTS – Architecture – Handover – Security	7
III.	**Mobile Network Layer:** Mobile IP – DHCP – AdHoc– Proactive protocol-DSDV, Reactive Routing Protocols – DSR, AODV , Hybrid routing –ZRP, Multicast Routing- ODMRP, Vehicular Ad Hoc networks (VANET) – MANET Vs VANET – Security.	7

IV.	**Mobile Transport and Application Layer:** Mobile TCP– WAP – Architecture– WDP – WTLS – WTP –WSP – WAE – WTA Architecture – WML	**7**
V.	**Mobile Device Operating Systems:** Special Constraints & Requirements – Commercial Mobile Operating Systems	**7**
VI.	**Software Development Kit:** iOS, Android, BlackBerry, Windows Phone – MCommerce – Structure – Pros & Cons – Mobile Payment System – Security Issues	**7**

Textbooks:

1. Jochen Schiller, "Mobile Communications", PHI, Second Edition, 2003.
2. Prasant Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt.Ltd, New Delhi – 2012

References :

1. Dharma Prakash Agarval, Qing and An Zeng, "Introduction to Wireless and Mobile systems", homson Asia Pvt Ltd, 2005.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003.
3. BlackBerry Developer : http://developer.blackberry.com

CST313.3 : Data Mining and Warehousing							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Database System and Programming Experience

Course Outcomes: After the end of this course students will be able to

CO1 **Describe**[2] the data warehousing processes and data mining
CO2 **Identify**[3] data mining algorithms to solve given problem
CO3 **Construct**[3] data warehouse systems

Syllabus (Theory)

Units	Description	Hours
I.	**Data Preprocessing:** Data Preprocessing: An Overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization	7
II.	**Data Warehousing and Online Analytical Processing:** Data Warehouse: Basic Concepts, Data Warehouse Modeling: Data Cube and OLAP, Data Warehouse Design and Usage, Data Warehouse Implementation	7
III.	**Introduction to Data mining:** Why Data Mining? What Is Data Mining?, What Kinds of Data Can Be Mined?, What Kinds of Patterns Can Be Mined? Classification Algorithms: What is Classification? Supervised Learning, Classifier Accuracy, Decision Tree and Naïve Bayes Classifier.	7
IV.	**Clustering:** What is clustering? Types of data, Partitioning Methods (k-Means, k-Medoids) Hierarchical Methods(Agglomerative , Divisive)	7
V.	**Association Rule Mining:** Association rules: Motivation For Association Rule mining, Market Basket Analysis, Apriori Algorithm, FP tree Algorithm, Iceberg Queries	7

VI.	**Web Mining:** Introduction, web content mining, web structure mining, web usage mining	**7**

Textbooks:

1. Jiawei Han, Micheline Kamber , "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann Series, 2011 (For units 1, 2)
2. Dunham, Margaret H, "Data Mining - Introductory and Advanced Topics: Prentice Hall", 2002. (For units 3, 4, 5, 6)

References :

1. Daniel T. Larose, John Wiley, "Discovering Knowledge in Data: An introduction to Data Mining", 2nd Edition, 2014

CST313.4 : Business Analytics							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Data structures, Database Management System, Concepts of mathematics & statistics

Course Outcomes: After the end of this course students will be able to

CO1 **Explain**[2] basic of business analytics in view of IT Applications.

CO2 **Construct**[3] Business Intelligence framework through decision support and model OLTP and OLAP.

CO3 **Interpret**[5] data and use efficiently in data warehouse associated with the Business enterprise.

CO4 **Process**[3] multi-dimensional data by using various data modeling techniques within the purview of business analytics.

Syllabus (Theory)

Units	Description	Hours
I	**Business view of information technology applications:** Business Enterprise, Functions and Core Business Processes, Baldrige Business Excellence Framework, Purpose of Using IT in Business, Application development Approaches, Information Users and Their Requirements, Types of Digital Data: Structured Data, Unstructured Data, Semi-Structured Data, Characteristics, Issues& Challenges.	7
II	**Business intelligence:** BI Overview, BI Skill requirements, BI benefits, functions and Applications, Using Analytical Information for Decision Support, Role of DSS, EIS, MIS, Business Analytics, BI Component Framework, BI Users, Applications, Popular BI Tools.	7

III	**Introduction to OLTP and OLAP:**Characteristics, Issues and Challenges, Comparison, Dimensional Data, Different OLAP Architectures, ROLAP, MOLAP, HOLAP, Data Models for OLTP and OLAP, OLAP operations: Slice Dice, Roll Up, and Cube etc.	7
IV	**Data integration & data warehousing:**Strategic Information, Information Crisis, Need for Data Warehouse, Definition, Goals, Benefits, Use, Components, Data Marts, Ralph Kimball's AND W.H. Inmon's Approach, Extraction, Transformation & Loading, Data Integration.	7
V	**Multidimensional data modeling:** Introduction, Basics, Data models, Facts & Fact Table, Dimensions, Dimension Table, Subjects, Measures, Dimensional Models : Star Schema, Snowflake Schema etc. , Keys, Aggregate Tables	7
VI	**Metrics & KPIs:**Understanding Measures and Performance, Role of Metrics, KPIs, ENTERPRISE REPORTING: Report Standardization, Presentation, Balanced Scorecard, Dashboards	7

Textbooks:

1. R N Prasad, Seema Acharya, “Fundamentals of Business Analytics”, 2nd edition, Wiley India, 2011.

References :

1. Rajiv Sabherwal, Irma Becerra Fernandez, “Business Intelligence:ractice,Technologies and Management”, J. Wiley and sons,2011.

CST313.5 : Simulation and Modeling							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will be able to

CO1 **Illustrate**[2] concepts of modeling and simulation
CO2 **Estimate**[3] a model based upon input and output data
CO3 **Construct**[3] a model based upon input data

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:** Definitions of Modeling and Simulation, When to apply these techniques , Applications, Terminology & Components, Discrete vs. Continuous time , Process flow in simulation study	7
II.	**Simulation Examples:** Queuing systems ,Communications networks, General Principles -Event-driven simulation ,World Views ,List processing	
III.	**Simulation software:** History, Selection process, Simulation in High Level Language (C, C++, Pascal, Fortran), Simulation packages (Matlab/Simulink), Interpreted vs. compiled simulators, Future trends	7
IV.	**Statistical models:** Terminology and Concepts, Useful Statistical Models, Distributions, Queuing models, Characteristics, Performance Measures, Steady-State Behavior, Networks of Queues, Random Number Generation Properties of Random Numbers, Generation of Pseudo-Random Numbers , Testing for Randomness d. Pitfalls	7

V.	Input Modeling, Collecting Data, Identifying Distribution, Histograms, Parameter Estimation, Goodness-of-Fit, Selecting Input Model without Data	**7**
VI.	**Verification and Validation:** Model Building, Verification, and Validation, Verification of Simulation Models, Calibration and Validation of Models, Output Analysis	**7**

Textbooks:

1. Geoffrey Gordon, "System Simulation" , Prentice Hall publication, 2nd Edition, 1978, ISBN: 81- 203-0140-4

References :

1. Averill M Law, W David Kelton, "Simulation Modelling & Analysis", McGraw Hill International Editions – Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9.
2. Narsingh Deo, "Systems Simulation with Digital Computer", PHI Publication (EEE), 3rd Edition, 2004, ISBN : 0-87692-028-8.

CST313.6 : Computer Vision							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Mathematics – Linear algebra , Probability Theory

Course Outcomes: After the end of this course students will be able to

CO1 **Explain**[2] fundamental concepts of digital image processing, mathematical transforms, image enhancement, segmentation

CO2 **Choose**[3] algorithms to build solutions to the real world computer vision problems

CO3 **Assess**[5] algorithms with justification

Syllabus (Theory)

Units	Description	Hours
I	**Digital Image Fundamentals:** Introduction: Concept, Fundamental Steps and Components of Image Processing System, Image Acquisition, A simple image model, Sampling and Quantization, Imaging Geometry, Different types of digital images	7
II	**Image Transforms:** 2D systems and Necessary Mathematical preliminaries, 2D Orthogonal and Unitary Transforms, 1-D DFT, KL-Transforms, Cosine, Hadamard Transforms, Introduction to Wavelet transforms	7
III	**Image Enhancement :** Point Processing, Basic Gray Level Transformations, Histogram Processing, Spatial domain Filtering, Frequency domain filtering	7
IV	**Image Segmentation and Analysis :** Edge Detection – using first and second order derivatives, LoG, Canny edge detector, Boundary Extraction – Connectivity, Heuristic Graph Search, Hough Transform, Active Contour, Watershed Transform, Region-based Segmentation – region growing, region	7

	splitting and merging, Feature Extraction	
V	**Color Image Processing :** Color Fundamentals, Color models, Gray level to color transformations, Basics of Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation	**7**
VI	**Texture Analysis:** Definition, Types of texture, Texels, Texture analysis – concept and categories, Approaches to texture analysis, Statistics, Texture descriptors - statistical - Auto-correlation, co-occurrence matrices and features, edge density and direction, local binary partition, Law's texture energy measures, Wavelets and texture analysis.	**7**

Textbooks:

1. Gonzalez R. C., Woods R. E., "Digital Image Processing", PHI, Second Edition. 2002
2. Sonka Milan, Vaclav Hlavac, Boyle, "Digital Image Processing and Computer Vision", Cengage Learning, Third edition, 2013

References :

1. S. Jayaraman, S. Esakkirajan, T. Veerkumar, "Digital Image Processing", Tata McGraw Hill, Third edition, 2010
2. D. A. Forsyth, J. Ponce, "Computer Vision – A Modern approach", Pearson Education, Prentice Hall, 2005
3. Linda Shapiro, George C. Stockman, "Computer Vision", Prentice Hall, 2000

CST313.7 : Cyber Security							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Computer Networks / Network Engineering

Course Outcomes: After the end of this course students will be able to

CO1 **List**[1] different Cyber laws and acts

CO2 **Apply**[3] cyber security concepts in cybercrime investigations

CO3 **Experiment with**[3] the concepts of Digital forensics

CO4 **Classify**[4] cyber threats and attacks

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:** ISO/OSI and TCP/IP Protocol Stacks , Information Security Overview , Types of Attacks , E-commerce Security, Security threats, OWASP top Ten.	7
II.	**Cyber Crime Overview:** Introduction and Overview of Cyber Crime - Nature and Scope of Cyber Crime - Types of Cyber Crime: Social Engineering - Categories of Cyber Crime - Property Cyber Crime.	7
III.	**Cyber Crime Issues:** Unauthorized Access to Computers - Computer Intrusions - White collar Crimes - Viruses and Malicious Code - Internet Hacking and Cracking - Virus Attacks – Software Piracy - Intellectual Property - Mail Bombs - Exploitation - Stalking and Obscenity in Internet	7
IV.	**Cyber Crime Investigations:** Introduction to Cyber Crime investigations, Investigations Tools, E-Mail Investigation – Tracking - IP Tracking - E-Mail, Recovery - Hands on Case Studies - Encryption and Decryption Methods - - Recovering Deleted Evidences - Password Cracking.	7

V.	**Digital Forensics:** Introduction to Digital Forensics - Forensic Software and Hardware - Analysis and Advanced Tools - Forensic Technology and Practices - Forensic Ballistics and Photography - Face, Iris and Fingerprint Recognition - Audio Video Analysis - Windows System Forensics - Linux System Forensics	**7**
VI.	**Cyber Laws & Acts:** Laws and Ethics - Digital Evidence Controls - Evidence Handling Procedures - Basics of Indian Evidence ACT IPC and CrPC - Electronic Communication Privacy ACT - Legal Policies.	**7**

Textbooks:

1. Nelson, Phillips and EnfingerSteuart, "Computer Forensics and Investigations", Cengage Learning, New Delhi, 4th Edition, 2009.
2. Kevin Mandia, Chris Prosise, Matt Pepe, "Incident Response and Computer Forensics", Tata McGraw Hill, New Delhi, 2nd Edition, 2003.

References :

1. Robert M Slade, "Software Forensics", Tata McGraw Hill, New Delhi, 2004.
2. Bernadette H Schell, Clemens Martin, "Cybercrime",ABC CLIO Inc, California, 2004.

CST313.8 : Digital Forensics							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Students should have knowledge of Networking.

Course Outcomes: After the end of this course students will be able to

CO1 **Define**[1] the role of digital forensics.

CO2 **Identify**[3] the computing requirements appropriate to solve given problem.

CO3 **Explain**[2] the network forensics and methods of investigation using digital forensics techniques.

CO4 **Discuss**[2] professional, ethical, legal, security and social issues and responsibilities.

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:**	**7**
	Introduction of Cybercrime: Types, The Internet spawns crime, Worms versus viruses, Computers' roles in crimes, Introduction to digital forensics, Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response, Phase after detection of an incident.	
II.	**Initial Response and forensic duplication:**	**7**
	Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system – Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic,	

Duplicate/Qualified Forensic Duplicate of a Hard Drive.

III.	**Preserving and Recovering Digital Evidence:**	**7**

File Systems: FAT, NTFS - Forensic Analysis of File Systems – Storage Fundamentals: Storage Layer, Hard Drives Evidence Handling: Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure.

IV.	**Network Forensics:**	**7**

Intrusion detection; Different Attacks in network, analysis Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing- Internet Fraud

V.	**System investigation:**	**7**

Data Analysis Techniques - Investigating Live Systems (Windows & Unix) Investigating, Hacker Tools - Ethical Issues – Cybercrime.

VI.	**Bodies of law:**	**7**

Constitutional law, Criminal law, Civil law, Administrative regulations, Levels of law: Local laws, State laws, Federal laws, International laws, Levels of culpability: Intent, Knowledge, Recklessness, Negligence Level and burden of proof: Criminal versus civil cases ,Vicarious liability, Laws related to computers: CFAA, DMCA, CAN Spam, etc.

Textbooks:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGraw Hill, 2006
2. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001

References :

1. Skoudis. E., Perlman. R. “Counter Hack: A Step-by-Step Guide to Computer Attacks and Effective Defenses”, Prentice Hall Professional Technical Reference. 2001
2. Norbert Zaenglein, "Disk Detective: Secret You Must Know to Recover Information From a

Computer", Paladin Press, 2000

3. Bill Nelson, Amelia Philips and Christopher Steuart, “Guide to computer forensics investigation”, Cengage learning , 4th edition, 2013

CST315.1 : Wireless Sensor Networks Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Computer Networking, Wireless Adhoc Networks

Course Outcomes: After the end of this course students will be able to

CO1 **Use**[3] simulation tool for network protocols in wireless sensor network

CO2 **Construct**[4] simulation scenario for WSN

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Differentiate wireless sensor network tools (simulators and emulators).- Cooja,NS2,TOSSIM,OMNeT++,J-Sim, ATEMU, Avrora
2. Perform downloading and installation of network simulation tool
3. Implement wireless network for two nodes scenario
4. Implement wireless network for multiple nodes scenario
5. Perform analysis of different wireless sensors
6. Perform analysis of different wireless motes
7. Implement a wireless sensor network for performance throughput
8. Simulate a mobile Adhoc network
9. Implement Transport Control Protocol in sensor network
10. Implement routing protocol supporting wireless sensor network

Textbooks:

1. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks, Theory and Practice", 1st Edition, Wiley Publication, 2007

2. Kazem Sohraby, Daniel Manoli, "Wireless Sensor Networks - Technology, Protocols and Applications", 1st Edition, Wiley Inter-Science Publications, 2010

References :

1. Bhaskar Krishnamachari, "Networking Wireless Sensors", 1st Edition, Cambridge University Press, 2005

2. C.S Raghavendra, Krishna M.Sivalingam, Taieb Znati, "Wireless Sensor Networks", 1st Edition, Springer Science, 2004

4. Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols", 1st Edition, CRC Press, August 2003.

CST315.2 : Mobile Computing Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Network technologies

Course Outcomes: After the end of this course students will be able to

CO1 **Demonstrate**[2] the knowledge about orthogonal codes and J2ME

CO2 **Illustrate**[2] the knowledge about code division Multiplexing, WAP , WAP architecture & applications

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. To check orthogonality of two codes. Generation of Walsh codes.
2. To implement Code Division Multiple Access (CDMA).
3. To study frequency reuse.
4. To create a MIDletsuite with two MIDlets.
5. To study ChoiceGroup class and its implementation in J2ME.
6. To study Canvas class and its implementation in J2ME.
7. Write WML page using various tags such as select and option tags.
8. Write a WML page to display an image and to accept input from the user.
9. Study Assignment 1: Detailed study of Bluetooth.
10. Study Assignment 2 : Detailed study of Wireless Application Protocol .

Textbooks:

1. Jochen Schiller, “Mobile Communications”, PHI, Second Edition, 2003.

2. Prasant Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt.Ltd, New Delhi – 2012

References :

1. Dharma PrakashAgarval, Qing and An Zeng, "Introduction to Wireless and Mobile systems",Thomson Asia Pvt Ltd, 2005.
2. UweHansmann, LotharMerk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003.
3. William.C.Y.Lee, "Mobile Cellular Telecommunications-Analog and Digital Systems", Second Edition,TataMcGraw Hill Edition ,2006.
4. C.K.Toh, "AdHoc Mobile Wireless Networks", First Edition, Pearson Education, 2002.
5. Android Developers : http://developer.android.com/index.html
6. Apple Developer : https://developer.apple.com/
7. Windows Phone DevCenter : http://developer.windowsphone.com
8. BlackBerry Developer : http://developer.blackberry.com

CST315.3 : Data Warehousing and Data Mining Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Database Systems fundamentals

Course Outcomes: After the end of this course students will be able to

CO1 **Adapt**[3] various algorithms made available by popular commercial, open source data mining / data warehousing systems

CO2 **Compare**[4] different data warehousing/data mining tools/systems

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

Use standard data sets from UCI Machine Learning Repository for testing algorithms.
Use R / Python as Programming Language, for database programming / scripting use PL/SQL Oracle 11g or IBM DB2 9.7 as backend database server and Open source data warehousing/data mining tools.

1. Perform following using Weka API
   i. Data Preprocessing
   ii. Discretization of data
   iii. Attribute selection

iv. Classification algorithms
v. Apriori algorithm
vi. Clustering algorithms
vii. Visualization

2. Perform data transformations using an ETL Tool
3. Perform Dataset normalization using following methods. (a) min-max normalization by setting min = 0 and max = 1, (b) z-score normalization
4. Implement Apriori algorithm to generate frequent Item Sets and association rule.
5. Implement the following clustering algorithms
   i. k-Means
   ii. k-Mediods
6. Implement the following classification algorithms
   i. Decision Tree Induction
   ii. KNN

Textbooks:

1. Data Mining - Concepts & Techniques: Jiawei Han &Micheline Kamber, Morgan Kaufmann, 2012.

References :

1. Ramesh Sharda, Dursun Delen, David King, “Business Intelligence”, Second Edition; Efraim Publisher Turban,pearson Education, 2011
2. Berry, Gordon S. Linoff, “Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management”, John Wiley & Sons Inc publishers, 3 rd Edition, 2011

CST315.4 : Business Analytics Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Basic Data structures, Database Management System.

Course Outcomes: After the end of this course students will be able to

CO1 **Construct**[3] different data warehouse schema & data mining strategy using different Data collection

CO2 **Experiment**[4] Extract, Transform & Load on the unstructured & semistructured datasets

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Implement association rule mining with dataset transaction using R
2. Implement mathematical model for predictions of sells for unstructured & semi structured data using R
3. Write a program to generate the report for math analysis
4. Program to Implement cubical analysis of given data& decision tree for the given dataset
5. Program to implement data visualization using R Programming
6. Create a dashboard using the BI tools for the given sequence
7. Develop Predictive analytics model by using Linear & integer Programming
8. Program to implement charts using R for data

Textbooks:

1. R N Prasad, Seema Acharya, Fundamentals of Business Analytics, 2nd edition, Wiley India, 2011.

References:

1. Rajiv Sabherwal, Irma Becerra Fernandez, “Business Intelligence: Practice, Technologies and Management”, J. Wiley and sons,2011.

CST315.5 : Simulation and Modeling Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will be able to

CO1 Perform[3] different tests related to simulation and modeling

CO2 Implement[3] simulation models using input analyzer, and output analyzer

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

Perform following experiments using MATLAB/ Simulink etc.

1. Write a program to generate Random Numbers.
2. Perform Chi-square goodness-of-fit test
3. Perform One-sample Kolmogorov-Smirnov test
4. Perform Test for Standard Normal Distribution
5. Testing Random Number Generators.
6. Implement Monte-Carlo Simulation.
7. Simulation of Single Server Queuing System.
8. Simulation of Two-Server Queuing System.
9. Simulate and control a conveyor belt system
10. Two-sample Kolmogorov-Smirnov test

Textbooks:

1. Geoffrey Gordon, System Simulation, Prentice Hall publication, 2nd Edition, 1978, ISBN: 81-203-0140-4

References :

1. Averill M Law, W David Kelton, "Simulation Modelling & Analysis", McGraw Hill International Editions – Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9.
2. Narsingh Deo, "Systems Simulation with Digital Computer", PHI Publication (EEE), 3rd Edition, 2004, ISBN : 0-87692-028-8.

CST315.6 : Computer Vision Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Mathematics – Linear algebra , Probability Theory

Course Outcomes: After the end of this course students will be able to

CO1 Adapt[3] various image processing operations

CO2 Extract[3] visual information from images

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Implement operations on grayscale images
2. Implement image resampling
3. Program that reads an RGB image, performs the following transformations, and displays images:
   a) Displays each of the 3 RGB channels
   b) Transforms the RGB image into the HSV color space
   c) Creates and Displays the brightness/intensity image
   d) Creates the chromaticity coordinates and display image
4. Smooth the image using different filtering techniques
5. Implement different edge detection techniques
6. Program that uses the convolution method to perform spatial filtering on an image.
7. Write a function to compute the normalized histogram of an image and compare two histograms using the Chi_Square metric
8. Program to implement Texture Analysis
9. Morphological operations for binary images

Textbooks:

1. Gonzalez R. C., Woods R. E., "Digital Image Processing", PHI, Second Edition. 2002
2. Sonka Milan, Vaclav Hlavac, Boyle, "Digital Image Processing and Computer Vision", Cengage Learning, Third edition, 2013

References :

1. S. Jayaraman, S. Esakkirajan, T. Veerkumar, "Digital Image Processing", Tata McGraw Hill, Third edition, 2010
2. D. A. Forsyth, J. Ponce, "Computer Vision – A Modern approach", Pearson Education, Prentice Hall, 2005
3. Linda Shapiro, George C. Stockman, "Computer Vision", Prentice Hall, 2000

CST315.7 : Cyber Security Laboratory							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Information Security

Course Outcomes: After the end of this course students will be able to
CO1 Examine[4] Networking Commands, web browser, email, mobile security, passwords
CO2 Develop[3] program on the basis of cryptography

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Installation of Linux on virtual box.
2. Passwords Retrieval
3. Checking Web browser Security
4. Perform the experiments on Cryptography
5. Perform the experiments on Steganography
6. Checking Email Security
7. Experiments with Mobile Security Apps
8. Experimenting the concepts Ethical Hacking
9. Protection of Information Assets
10. Performing Website Penetration testing

Textbooks:

1. Nelson Phillips and EnfingerSteuart, “Computer Forensics and Investigations”, Cengage Learning, New Delhi, Fourth Edition, 2009.
2. Kevin Mandia, Chris Prosise, Matt Pepe, “Incident Response and Computer Forensics”, Tata McGraw Hill, New Delhi, 2nd Edition, 2003.

References :

1. Robert M Slade, “Software Forensics”, Tata McGraw Hill, New Delhi, 2005.
2. Bernadette H Schell, Clemens Martin, “Cybercrime”, ABC – CLIO Inc, California, 2004.

CST302 : Computer Organization and Architecture							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Microprocessor, Digital Systems.

Course Outcomes: After the end of this course students will be able to

CO1 **Explain**[2] different computer architectures

CO2 **Identify**[3] memory organizations

CO3 **Compare**[4] of loosely coupled and tightly coupled architectures

CO4 **Classify**[4] different pipeline architectures and performance measures

Syllabus (Theory)

Units	Description	Hours
I	**Introduction:** State of computing, Multiprocessor and Multicomputer, SIMD Computers, Architectural development tracks, Trends in Power and Energy in Integrated Circuits, Trends in Cost, Dependability Measuring.	7
II	**Principles of Pipelining and Vector Processing:** Pipelining, linear pipelining, classification of Pipeline Processors, Interleaved memory organizations, performance evaluation factors, Vector processing concepts, characteristics, pipelined vector processors, Cray type vector processor -design e.g. Array processors, Systolic arrays.	7
III	**Different parallel processing architectures:** Introduction to Associative memory processors, Multithreaded architecture – principles of multithreading, Latency hiding techniques, Scalable coherent multiprocessor model with distributed shared memory.	7
IV	**Distributed Memory Architecture :**	7

	Loosely coupled and tightly coupled architectures. Cluster computing as an application of loosely coupled architecture. Examples –CM	
V	**Data-Level Parallelism in Vector, SIMD and GPU Architectures :** Introduction, Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units Detecting and Enhancing Loop-Level Parallelism, Crosscutting Issues Mobile versus Server GPUs and Tesla versus Core i7	7
VI	**Program and Network Properties:** Conditions of parallelism Data and Resource Dependences, Data dependency analysis -Bernstein's condition, Hardware and Software Parallelism. , Grain Sizes and Latency, Grain Packing and Scheduling.	7

Textbooks:

1. Kai Hwang, "Advanced computer architecture", MGH publication,2008. (for Unit 1, 3 &6)
2. Kai Hwang & Briggs "Computer Architecture & Parallel Processing" MGH publication, 1st Edition, 2017.(for Unit 2 & 4).
3. John L. Hennessy and David A. Patterson "Computer Architecture -A Quantitative Approach", Elsevier publication, fifth Edition, 2011. (For Unit 5 & 1)

References :

1. DezsoSima, Terence Fountain & Peter Kacsuk, "Advanced computer Architecture" Pearson Education, First edition, 2002.
2. Barry Wilkinson & Michael Allen, "Parallel Programming Techniques &Applications using Networked Workstations & Parallel Computers", Second Edition Pearson Education, 2006.
3. Kai Hwang & NareshJotwani "Advanced Computer Architecture", McGraw Hill Publications, Second edition, 2016.

CST304 : Computer Organization and Architecture Laboratory							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Microprocessor, Digital Systems

Course Outcomes: After the end of this course students will be able to:

CO1 **Demonstrate**[2] different pipeline architectures and performance measures

CO2 **Summerize**[2] loosely coupled and Tightly coupled architectures

Contents

Two hours per week per batch practical is to be utilized for presentation, comparison and study of different architectures. To ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 topic presentations. Students of different batches should give separate presentation based on the following guidelines-

1. Compare Multiprocessor and Multicomputer.
2. Describe SIMD Computers Architectures
3. Demonstrate Cray type vector processor.
4. Compare Array processors, Systolic arrays.
5. Describe Associative memory processors.
6. Demonstrate Multithreaded Architecture.
7. Compare loosely coupled and tightly coupled architectures.
8. Describe Cluster computing examples.
9. Describe Graphics Processing Units architectures.
10. Compare Mobile versus Server GPUs.
11. Compare Tesla versus Core i7.
12. Compare Conditions of parallelism

Textbooks:

4. Kai Hwang “Advanced computer architecture”, MGH publication,2008 (for Unit 1, 3 &6)
5. Kai Hwang & Briggs, “Computer Architecture & Parallel Processing”, MGH publication, 1st Edition, 2017.(for Unit 2 & 4).

6. John L. Hennessy and David A. Patterson, "Computer Architecture -A Quantitative Approach", Elsevier publication, 5th Edition, 2011. (For Unit 5 & 1)

References :

4. Dezso Sima, Terence Fountain & Peter Kacsuk, "Advanced computer Architecture", Pearson Education, 1st edition, 2002.
5. Barry Wilkinson & Michael Allen, "Parallel Programming Techniques &Applications using Networked Workstations & Parallel Computers", second edition Pearson education, 2006.
6. Kai Hwang &Naresh Jotwani, "Advanced Computer Architecture", McGraw Hill Publications, second edition, 2016.

CST306 : Advanced Database Systems							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: DBMS concepts, SQL, Object oriented properties, Java programming language basics.

Course Outcomes: After the end of this course students will be able to

CO1 **Classify[2],** various types of database architectures based on the domain of application.

CO2 **Use[3]** advanced query writing techniques with PL/SQL to solve database problems

CO3 **Illustrate[3]** the use of XML databases for information retrieval.

CO4 **Analyze[4]** the effectiveness of NoSQL and Big Data in specific database applications.

Syllabus (Theory)

Units	Description	Hours
I	**ORDBMS and OODBMS: S**tructured data types, Operations on structured data, Encapsulation and ADTs, Inheritance, Objects, OIDS and Reference types, Database design for an ORDBMS. Object identity, Nested collections. Introduction to Object Database Management Group(ODMG),Object Definition Language (ODL) and Object Query Language(OQL)- SELECT and sub queries. Comparison of RDBMS, ORDBMS and OODBMS.	7
II	**Advanced SQL:** PL/SQL- A Basic introduction, Functions and Procedure, Packages, Synonyms, Database Links, Embedded SQL and Dynamic SQL. Database Design: systems development life cycle, database life cycle, DBMS Software Selection: top-down versus bottom-up design.	7
III	**Information Retrieval & XML data:** Introduction to information retrieval, Indexing for Text search. Overview and structure of XML data, Data model for XML, XML DTD's, Domain specific DTD's, Querying XML data, XML Applications.	7

IV	**NoSQL & Introduction to Big Data:** Types of digital data: Structured, unstructured and semi-structured. Definition of Big Data. Why big data. Traditional Business Intelligence (BI) vs Big Data. NoSQL: Types, advantages and use of NoSQL in industry. Comparison of SQL, NoSQL and NewSQL. Introduction to Hadoop: Features and key advantages of Hadoop. The Hadoop ecosystem: HDFS and map reduce. Introduction to interacting with Hadoop eco system: Pig, Hive, Scoop, HBase.	**7**
V	**MongoDB - A NoSQL Database:** Definition and need of MongoDB. Javascipt programming, Datatypes in MongoDB. MongoDB Query Language: Insert, save methods, add/remove fields to/from documents, arrays, aggregate functions, Mapreduce function, Mongo import, Mongo export.	**7**
VI	**Current Trends In Advanced Databases:** Introduction to different types of databases and application areas: Multimedia Database, Cloud Databases, Spatial Databases, Temporal Databases, Mobile Databases, Deductive databases.	**7**

Textbooks:

1. Elmasri Ramez, Navathe Shamkant, "Fundamentals of Database System", Pearson publications, 6th Edition, 2013.
2. P.S. Deshpande, "SQL & PL/SQL for Oracle Black Book", Dreamtechpress, 1st edition, 2012.
3. Seema Acharya and Subhashini Chellappan, "Big data and Analytics", Wiley publications, 1st Edition, 2015.

References :

1. Mario Piattini, Oscar Diaz, "Advanced Database Technology and Design", Artech House Inc, 1st edition, 2000.
2. Raghu Ramkrishanan, Johannes Gehrke, "Database Management Systems", McGraw Hill Publications, 3rd edition, 2003.
3. http://nosql-database.org/

CST308 : Advanced Database Systems Laboratory							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	50	40
					POE	50	40

Prerequisite: Basic programming knowledge, DBMS

Course Outcomes: After the end of this course students will be able to

CO1 **Use**[3] advanced database programming techniques to solve complex problems of data management.

CO2 **Prepare**[3] database model using advanced techniques, for data maintenance and analysis purpose.

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines:

1. Develop an application using multi-valued attributes, complex types, procedures and functions in ORDBMS.
2. Implement a database application to study PL/SQL concepts and features.
3. Embed PL/SQL in a high-level host language such as C and demonstrate a transaction application.
4. Create XML, XML schemas, DTD for any database application and implement queries using XQuery and XPath. This can be done in two experiments.
5. Installation of Hadoop.
6. Performing queries to demonstrate use of HDFS and Mapreduce.
7. Design database schemas and implement queries using Hive/ Hbase.

Textbooks:

4. Abraham Silberschatz, Henry Korth, S, Sudarshan , “Database System Concepts”, McGraw Hill International, 6th Edition, 2015.
5. Raghu Ramkrishanan, Johannes Gehrke, “Database Management Systems”, McGraw Hill International, 3rd Edition, 2003.

References :

1. Tom White, “Hadoop: The Definitive Guide”, O’Reilly Publications, 4th edition, 2015.
2. Silberschatz A., Korth H., Sudarshan S, "Database System Concepts”, McGraw Hill Publishers, 6th Edition, 2015.
3. Jiawei Han, Micheline Kamber, Jian Pei, “Data Mining: Concepts and Techniques”, Morgan Kaufmann Publishers, 3rd Edition, 2011.
4. http://nosql-database.org/
5. http://www.objectdb.com/database/jdo

CST310 : Machine Learning							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Computer Algorithm

Course Outcomes: After the end of this course students will be able to

CO1 **Explain**[2] basic concepts of machine learning

CO2 **Identify**[3] machine learning techniques suitable for a given problem

CO3 **Solve**[3] the problems using various machine learning techniques

CO4 **Compare**[2] various machine learning techniques for optimization

Syllabus (Theory)

Units	Description	Hours
I	**Introduction :** Supervised and unsupervised learning, Hypothesis space, Applications of machine learning, Feature selection and extraction, Principal component analysis	7
II	**Supervised learning:** Bias-Variance Dichotomy, Linear regression in one variable: Cost Function, Gradient descent; Linear Regression with Multiple Variables: Gradient descent; Logistic regression, KNN	7
III	**Supervised learning:** Bayesian Learning and Decision Trees, SVM, Ensemble Methods	7
IV	**Unsupervised learning:** clustering, k-means, hierarchical agglomeration, EM	7
V	**Evaluation of Learning Algorithms:** Cross-validation, learning curves, and statistical hypothesis testing	7
VI	**Machine Learning based Artificial Neural Networks:** Fundamentals of Artificial Neural Networks, Perceptrons, Model of Neuron in an ANN, Backpropagation, Introduction to deep learning	7

Textbooks:

1. Coursera online course byAndre NG, on Machine Learning.
2. http://www.stanford.edu/class/cs229/materials.html
3. T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning (2ed.), 2008.

References :

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, 2016
2. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, “Introduction to Statistical Learning”, Springer, 2013
3. Richard Duda, Peter Hart, David Stork, “Pattern Classification”, John Wiley & Sons, Second edition 2001.
4. NPTEL online course by Prof. Balaraman Ravindran on Introduction to Machine Learning.

CST312 : Machine Learning Laboratory							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	50	40
					POE	50	40

Prerequisite: Computer Algorithm, basics of computer programming

Course Outcomes: After the end of this course students will able to

CO1 **Demonstrate**[2] basic concepts of machine learning

CO2 **Solve**[3] the problems using various machine learning techniques

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Implementation of feature selection and extraction algorithm.
2. Implementation of linear regression.
3. Implementation of logistic regression.
4. Implementation of KNN algorithm.
5. Implementation of decision tree.
6. Implementation of Naïve Bayesian classifier.
7. Implementation of Bayesian network.
8. Clustering Based on EM algorithm.
9. Clustering Based on k-Means algorithm.
10. Implementation of evaluation techniques.
11. Implementation of back propagation for ANN.

Textbooks:

1. T. Hastie, R. Tibshirani, J. Friedman,"The Elements of Statistical Learning", 2e, 2008
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer 2006

References :

5. Christopher Bishop, “Pattern Recognition and Machine Learning”, 2016
6. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani , “Introduction to Statistical Learning”, Springer, 2013
7. Richard Duda, Peter Hart, David Stork, “Pattern Classification”, John Wiley & Sons, 2e,2001
8. NPTEL online course by Prof. Balaraman Ravindran on “Introduction to Machine Learning”

CST314.1 : Advanced Network Technology							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Computer Networking, Wireless Adhoc Networks

Course Outcomes: After the end of this course students will be able to

CO1 **Describe**[2] different wireless technologies, Wireless LAN protocols and security issues

CO2 **Classify**[4] the Personal Area Network (PANs) architecture and its standards.

CO3 **Compare**[5] MAC layer, Routing and network layer protocols.

CO4 **Summarize**[2] Security in wireless Access Protocol, wireless sensor networks, Wireless PANs, Wireless protocols and security in wireless access Protocol.

Syllabus (Theory)

Units	Description	Hours
I.	**ıtroduction:** ifferent generations of wireless cellular Networks, 1G to 4G Cellular systems and beyond, GSM system overview, Introduction to GSM, GSM Network and system Architecture, GSM Channel Concept, GSM Identities, GSM system operations	7
II.	**Basic Wireless Sensor Technology:** Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating environment, , Wireless Transmission Technology and Systems, Radio Technology Primer, Available Wireless Technologies, Medium Access Control Protocols for Wireless Sensor Networks	7
III.	**Routing Protocols for Wireless Sensor Networks:** Data Dissemination and Gathering, Routing Challenges and Design Issues	7

	in Wireless Sensor Networks, Routing Strategies ,Transport Control Protocols for Wireless Sensor Networks, Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols	
IV.	**WSN Middleware Principles:**	
	Middleware Architecture, Network Management for Wireless Sensor Networks, Network Management Requirements, Traditional Network Management Models, Network Management Design Issues, Example of Management Architecture: MANNA	**7**
V.	**Operating Systems for Wireless Sensor Networks:**	
	Operating System Design Issues, Examples of Operating Systems, TinyOS, Mate, MagnetOS, MANTIS, OSPM,EYES OS, SenOS, EMERALDS, PicOS	**7**
VI.	**Performance and Traffic Management:**	
	Introduction, Background, WSN Design Issues, MAC Protocols, Routing Protocols, Transport Protocols, Performance Modeling of WSNs, Performance Metrics, Basic Models, Network Models, Case Study: Simple Computation of the System Life Span	**7**

Textbooks:

1. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks, Theory and Practice”, 1st Edition, John Wiley & Sons, 2007.

2. Kazem Sohraby, Daniel Manoli “Wireless Sensor Networks- Technology, Protocols and Applications”, 1st Edition ,Wiley InterScience Publications, 2010.

References :

1. Bhaskar Krishnamachari, "Networking Wireless Sensors”, 1st Edition, Cambridge University Press, 2005

2. C.S Raghavendra, Krishna M.Sivalingam, Taieb znati, ”Wireless Sensor Networks”, 1st Edition, Springer Science, 2004

3. Edgar H. Callaway, Jr. and Edgar H. Callaway,”Wireless Sensor Networks: Architectures and Protocols”, 1st Edition, CRC Press, 2003.

CST314.2 : Internet of Things							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will be able to

CO1 **Illustrate**[2] the concept of IoT
CO2 **Categorize**[4] various protocols for IoT
CO3 **Identify**[3] different technologies of IoT
CO4 **Solve**[3] problems by using IoT concepts

Syllabus (Theory)

Units	Description	Hours
I.	**Fundamentals of IoT:** Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoTecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects6	7
II.	**IoT Protocols, IoT Access Technologies:** Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT	7
III.	**Design And Development:** Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.	7
IV.	**Data Analytics And Supporting Services:** Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem	7
V.	**Apache Kafka Apache Spark:** Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG	7

VI.	**Case Studies/Industrial Applications:** Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control	**7**

Textbooks:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies", Protocols and Use Cases for Internet of Things, Cisco Press, 2017

References :

1. ArshdeepBahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press,2015
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.
4. https://www.arduino.cc/https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet

CST314.3 : Intelligent Systems							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Programming, Data Structures.

Course Outcomes: After the end of this course students will be able to

CO1 **Make use of**[3] different types of Agents in Artificial Intelligence to solve problems
CO2 **Choose**[3] an appropriate problem-solving method and knowledge-representation scheme
CO3 **Differentiate**[4] types of learning techniques in Artificial Intelligence
CO4 **Compare**[5] different types of systems in Artificial Intelligence

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:** Definition, Introduction to AI, - Future of Artificial Intelligence Characteristics of Intelligent Agents, Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent	7
II.	**Problem Solving:** Solving problems by searching, Problem formulation, Search Strategies, Uninformed Search Techniques-DFS, BFS, Uniform cost search, Informed search methods-Best First Search, heuristic Functions, Hill Climbing, A*,CSP	7
III.	**Knowledge and Reasoning:** A knowledge Based Agent, WUMPUS WORLD Environment, Propositional Logic, First Order Predicate Logic Syntax and Semantics, Unification, Forward and backward chaining	7
IV.	**Uncertain Knowledge and Reasoning:**	7

Uncertainty, Representing Knowledge in an Uncertain Domain, Probability, Bays Theorem, Belief Networks, Simple Inference in Belief Networks

V. Learning and Planning: 7

General Model of Learning Agents, Types of Learning-Supervised, Unsupervised, Reinforcement Learning,

Planning: A Simple Planning Agent, Planning in Situation calculus, Basic representation for planning, A Partial Order Planning

VI. Expert systems: 7

Expert systems – Architecture of expert systems, Roles of expert systems, Knowledge Acquisition, Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART

Textbooks:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 2nd Edition, Pearson Publication, 2009.
2. Robin R Murphy, "Introduction to AI Robotics", ISBN-81-203-2458-7, 2nd Edition, PHI Publication, 2000.

References :

1. Patrick H. Winston, "Artificial Intelligence", 3 rd Edition, Pearson Publication, 1992.
2. George Lugar, "Al-Structures and Strategies for Complex Problem Solving", 6th Edition, Pearson Educations, 2002.
3. Nils J. Nilsson, "Principles of Artificial Intelligence", 1st Edition, Elsevier Publication, 1982.

CST314.4 : Recommender systems							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Data Structures

Course Outcomes: After the end of this course students will be able to

CO1 **Construct**[3] recommendation system for a particular application domain.
CO2 **Assess**[4] recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity.

CO3 **Explain**[2] different evaluation methods for RSs. .
CO4 **Classify**[4] different RSs solutions.

Syllabus (Theory)

Units	Description	Hours
I	**Introduction:** Preferences and Ratings, Predictions and recommendations, taxonomy of recommenders, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.	7
II	**Content based filtering:** Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, pre-processing and feature extraction, obtaining item features from tags, TF-IDF, Case-Based Reasoning, Classification techniques.	7
III	**Collaborative Filtering:** User-User Collaborative Filtering, Influence Limiting and Attack Resistance, Trust-Based Recommendation, Impact of Bad Ratings, Item-Item Collaborative Filtering.	7
IV	**Hybrid Approaches:** Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.	7
V	**Evaluating Recommender System:** Introduction, The goal of evaluation, Hidden data evaluation, prediction accuracy metrics, decision support metrics, rank-aware top-n metrics.	7

VI	**Types of Recommender Systems:** Recommender systems in personalized web search, knowledge-based recommender system, Social tagging recommender systems, Trust-centric recommendations, Group recommender systems.	7

Textbooks:

1. Coursera.org, course on "Introduction to Recommender Systems: Non-Personalized and Content-Based"

References :

1. Jannach D., Zanker M. and FelFeringA, "Recommender Systems: An Introduction, Cambridge University Press", First edition, 2011.
2. AggarwalCharu, "Recommender Systems: The Textbook", Springer, First edition, 2016.
3. Ricci F, Rokach L, Shapira D, Kantor B.P.,"Recommender Systems Handbook", Springer, First edition, 2011.
4. Manouselis N, Drachsler H, Verbert K, Duval E, "Recommender Systems For Learning", Springer, First edition, 2013.

CST314.5: High Performance Computing							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Computer Algorithm

Course Outcomes: After the end of this course students will be able to

CO1 **Distinguish**[4] algorithms in the computational area for efficient programming in modern computer architectures

CO2 **Make use of**[3] suitable algorithms for scientific computations

CO3 **Make use of**[3] tools for performance optimization and debugging

CO4 **Compare**[4] parallel processing architectures based on their performance

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:** Introduction to Parallel Computing ,Scope of Parallel Computing, Organization and Contents of the Text, Parallel Programming Platforms, Implicit Parallelism, Trends in Microprocessor & Architectures, Limitations of Memory System Performance.	7
II.	**Parallel Processing:** Dichotomy of Parallel Computing Platforms ,Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines Levels of parallelism , Parallelism models SIMD, MIMD, SIMT, SPMD, Demand-driven Computation, Architectures: N-wide superscalar architectures, multi-core and multi-threaded.	7
III.	**Parallel Programming Techniques:** Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, Processor Architecture, Interconnect, Communication,	7

Memory Organization, and Programming Models in high performance computing architecture ,micro-architecture Memory hierarchy and transaction specific memory design, Thread Organization.

IV.	**Parallel Programming Paradigm:** Programming Using the Message-Passing Paradigm: Principles of Message-Passing Programming, Send and Receive Operations, the Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, One-Dimensional Matrix-Vector Multiplication, Two-Dimensional Matrix-Vector Multiplication.	**7**
V.	**Scheduling:** Scheduling, Job Allocation, Job Partitioning, Dependency Analysis Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms.	**7**
VI.	**Synchronization:** Programming Shared Address Space Platforms: Thread Basics, need, The POSIX Thread API, Thread Basics: Creation and Termination, Synchronization Primitives in Pthreads, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, Tips for Designing Asynchronous Programs, OpenMP: a Standard for Directive Based Parallel Programming.	**7**

Textbooks:

1. Kai Hwang, “Advanced Computer Architecture: Parallelism, Scalability, programmability”, McGraw Hill, 1993.
2. David Culler, Jaswinder, Pal Singh, “Parallel Computer Architecture: A hardware/Software Approach”, Morgan Kaufmann, 1999.
3. Rezaur Rahman, “Intel Xeon Phi Coprocessor Architecture and Tools” Apress Open, 2013.

References :

1. Kai Hwang, “Scalable Parallel Computing”, 2004.

CST314.6: Human-Computer Interaction							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will be able to

CO1 **Illustrate**[2] concepts of HCI

CO2 **Construct**[3] problem solving methods in HCI

CO3 **Appraise**[5] applicability of HCI designs in solving engineering problems

CO4 **Demonstrate**[2] typical HCI system

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:** Course objective and overview, Historical evolution of the field, The Human, The Computer, The Interaction.	7
II.	**Design processes:** Interaction Design basics, Concept of usability – definition and elaboration, HCI in the Software Process, Design Rules.	7
III.	**Implementation and Evaluation:** Implementation Support, Evaluation Techniques, Universal Design, Use Support.	7
IV.	**Models:** Cognitive Models, Socio – Organizational Issues and Stakeholders Requirements, Communication and Collaboration models.	7
V.	**Theories:** Task Analysis Dialog notations and Design Models of the system, Modeling Rich Interactions.	7
VI.	**Modern Systems:** Group ware, Ubiquitous Computing and Augmented Realities Hypertext, Multimedia and World Wide web.	7

Textbooks:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, “Human Computer Interaction”, 3rd Edition Pearson Education, 2003

2. B. Shneiderman, “Designing the User Interface”, Addison Wesley 2000 (Indian Reprint)

References :

1. Preece J, Rogers Y, Sharp H, Baniyon D, Holland S and Carey T, “Human Computer Interaction”, Addison-Wesley, 1994

CST314.7 : Ethical Hacking							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Computer Network

Course Outcomes: After the end of this course students will be able to

CO1 **Identify**[2] how intruders escalate privileges
CO2 **Implement**[3] Intrusion Detection, Policy Creation, Social Engineering,
CO3 **Evaluate**[4] different types of Attacks and their protection mechanisms
CO4 **Demonstrate**[3] hacking of web server.

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction** Types of Data Stolen From the Organizations, Elements of Information Security, Authenticity and Non-Repudiation, Security Challenges, Effects of Hacking, Hacker – Types of Hacker, Ethical Hacker.	7
II.	**Penetration Testing** Hacktivism - Role of Security and Penetration Tester, Penetration Testing Methodology, Networking & Computer Attacks – Malicious Software (Malware), Protection Against Malware, Intruder Attacks on Networks and Computers	7
III.	**Foot Printing And Social Engineering** Web Tools for Foot Printing, Conducting Competitive Intelligence, Google Hacking, Scanning, Enumeration, Trojans & Backdoors, Virus & Worms, Proxy & Packet Filtering, Denial of Service, Sniffer, Social Engineering – shoulder surfing, Dumpster Diving, Piggybacking	7
IV.	**Data Security** Physical Security – Attacks and Protection, Steganography – Methods, Attacks and Measures	7
V.	**Network Protection System** Routers, Firewall & Honeypots, IDS & IPS, Web Filtering, Vulnerability,	7

Penetration testing, Session Hijacking

VI.	**Hacking Web Servers** Web Server, Email Hacking, Incident Handling & Response, Bluetooth Hacking, Mobiles Phone Hacking	**7**

Textbooks:

1. Michael T. Simpson, Kent Backman, James E, "Corley, Hands-On Ethical Hacking and Network Defense", Second Edition, CENGAGE Learning, 2010.

References :

1. Steven DeFino, Barry Kaufman, Nick Valenteen, "Official Certified Ethical Hacker Review Guide", CENGAGE Learning, 2009-11-01.
2. Whitaker & Newman, "Penetration Testing and Network Defense", Cisco Press, Indianapolis, IN, 2006.
3. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy", Syngress Basics Series – Elsevier, August 4, 2011.

CST314.8 : Risk Assessment and Security Audit							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	3	Theory	FET	20	40
					CAT I	15	
					CAT II	15	
					ESE	50	40

Prerequisite: Data Structures

Course Outcomes: After the end of this course students will be able to

CO1 **Identify**[3] information Risks

CO2 **Collect**[3] information for auditing

CO3 **Assess**[3] Risk levels

CO4 **Explain**[2] procedure for information auditing

Syllabus (Theory)

Units	Description	Hours
I.	**Introduction:** What is Risk?–Information Security Risk Assessment, Overview- Drivers, Laws and Regulations- Risk Assessment Frame work – Practical Approach	7
II.	**Data Collection:** The Sponsors- The Project Team- Data Collection, Mechanisms- Executive Interviews- Document Requests- IT Assets Inventories- Profile & Control Survey- Consolidation.	7
III.	**Data Analysis:** Compiling Observations- Preparation of catalogs- System Risk Computation- Impact Analysis Scheme- Final Risk Score.	7
IV.	**Assessment:** System Risk Analysis- Risk Prioritization- System Specific Risk, Risk Treatment- Issue Registers- Methodology- Result- Risk Registers- Post Mortem	7
V.	**Security Audit Process:** Pre-planning audit- Audit Risk Assessment.	7
VI.	**Performing Audit**: Internal Controls- Audit Evidence- Audit Testing- Audit, Finding- Follow-up activities	7

Textbooks:

1. Mark Talabis, "Information Security Risk Assessment Toolkit: Practical Assessments through Data Collection and Data Analysis, Syngress", 1st edition, ISBN: 978-1-59749-735-0, 2012.

References :

1. David L. Cannon, CISA Certified Information Systems Auditor Study Guide, John Wiley & Sons, ISBN: 978-0-470-23152-4, 2009

CST316.1: Advanced Network Technology Laboratory (Version 1.0, Program Vertical, School of Technology)							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Basic C programming knowledge, Socket Programming, Core JAVA

Course Outcomes: After the end of this course students will be able to

CO1 **Experiment**[3] on Code Division Multiple Access(CDMA), WML pages by using WML tags and access points

CO2 **Implement**[3] concept of networking by using NS2

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Write a program to implement mobile network using NS2.
2. Write a program for providing security for transfer of data in the network. (RSA Algorithm)
3. Write a program to implement dynamic routing strategy in finding optimal path for data transmission.(Bellman ford algorithm).
4. Write a program to archive Traffic management at Flow level by implementing Closed Loop Control technique. (Leaky Bucket Algorithm)
5. Write a program to implement Link State Routing (Dijkstra Algorithm).
6. Write a program for encrypting 64 bit playing text using DES algorithm.
7. To demonstrate frequency reuse concept.
8. Simulation Programs using OPNET /NS2 or any other equivalent software- Three node point to point network with duplex links between them. Set the Queue size and vary the bandwidth and find the number of packets dropped.
9. Simulation Programs using OPNET /NS2 or any other equivalent software- Four-node point- to-point network, and connect the links as follows: n0->n2, n1->n2 and n2->n3. Apply TCP agent changing the parameters and determine the number of packets sent/received by TCP/UDP
10. Simulation Programs using OPNET /NS2 or any other equivalent software- The different types of internet traffic such as FTP and TELNET over network and analyze the throughput.
11. To implement the concept of J2ME.
12. To demonstrate various classes (such as TextBox, ChoiceGroup , Drop Down menus etc.) and

their implementation in J2ME.

13. To implement program for Wireless Application Protocols
14. Study Assignment 1: To study network Security Software.
15. Study Assignment 2: Detailed study of Bluetooth

Textbooks:

1. James Kurose and Keith Ross, Addison Wesley, "Computer Networking, A top-Down Approach", 4th Ed. 2008

References :

1. Cisco website (www.cisco.com) for technical data sheets of devices.

CST316.2 : Internet of Things Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Networking Concepts

Course Outcomes: After the end of this course students will be able to

CO1 **Construct**[3] applications in IOT

CO2 **Evaluate**[5] the data received through sensors in IOT

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Install IDE of Arduino and different types of Arduino.
2. Write program using Arduino IDE for Blink LED.
3. Write Program for RGB LED using Arduino.
4. Write Program for monitor temperature using Arduino.
5. Implement RFID using Arduino.
6. Implement NFC using Arduino.8.Configure Raspberry Pi
7. Implement MQTT protocol using Arduino.
8. Configure Raspberry Pi
9. WAP for LED blink using Raspberry Pi.
10. Implement Zigbee Protocol using Arduino.
11. Implement Zigbee Protocol using Raspberry Pi.

*Mini Projects based on above topics can be given

Textbooks:

1. "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things",

Cisco Press, 2017

References :

1. Arshdeep Bahga, Vijay Madisetti, —"Internet of Things – A hands-on approach", Universities Press, 2015
2. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

CST316.3 : Intelligence Systems Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Programming, Data Structures.

Course Outcomes: After the end of this course students will be able to

CO1 **Demonstrate**[3] constraints satisfaction problems in Artificial Intelligence

CO2 **Select**[4] appropriate searching technique and libraries to solve the AI problem

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Write a program to make use of pre-processing libraries-standardization & normalization and predefined libraries e.g., PANDAS, NumPI
2. Write a program to implement Single Player Game (Using Heuristic Function)
3. Write a program for diagnosis the diseases
4. Implementation of A* Algorithm
5. Implementation of Tic-Tac-Toe game problem
6. Implementing WUMPUS world problem.
7. Implementation of Water jug Problem
8. Implementation of 8 puzzle problem
9. Implementation of Traveling salesman problem
10. Solve any problem using depth first search
11. Write a Program to find factorial of given number
12. Write a Program to detect species of Animal

Textbooks:

3. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 2nd Edition, Pearson Publication, 2009.
4. Robin R Murphy, “Introduction to AI Robotics”, ISBN-81-203-2458-7, 2nd Edition, PHI Publication, 2000.

References :

1. Patrick H. Winston, Artificial Intelligence, 3 rd Edition, Pearson Publication, 1992.
2. George Lugar, Al-Structures and Strategies for Complex Problem Solving,6th Edition, Pearson Educations, 2002.
3. Nils J. Nilsson, Principles of Artificial Intelligence, 1st Edition, Elsevier Publication, 1982.

CST316.4 : Recommender system Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	50	40

Prerequisite: Data Structures

Course Outcomes: After the end of this course students will able to

CO1 **Construct**[3] recommendation system for a particular application domain
CO2 **Assess**[4] recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Experiment to analyze different data mining methods for recommender Systems
2. Design content based recommendation system.
3. Comprehensive Survey of Neighborhood-based recommendation methods.
4. Developing Collaborative Filtering techniques in recommender system
5. Developing Constraint-based and context-aware recommenders
6. Empirical analysis of predictive algorithm for collaborative filtering
7. Evaluating Recommendation Systems(online evaluation)
8. Applying recommendation Algorithms for Social Tagging systems
9. Study Advanced Algorithms for aggregation of preferences in recommender systems
10. Experiment on active Learning techniques in Recommender Systems

Textbooks:

1.Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction: Cambridge University Press, First edition, 2011.

References :

1. Aggarwal Charu, Recommender Systems: The Textbook, Springer, First edition, 2016.

2. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook , Springer, First edition, 2011.
3. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer,First edition, 2013.

CST316.5: High Performance Computing Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Computer algorithm, some experience programming in Java, C, C++

Course Outcomes: After the end of this course students will be able to

CO1 **Demonstrate**[2] high performance versions of standard single threaded algorithms

CO2 **Experiment**[3] with the architectural features in the GPU and MIC hardware accelerators to achieve maximum performance through parallel programming

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Implement a program for vector addition
2. Program for matrix multiplication and tiled matrix multiplication
3. Demonstrate Picture scaling, image great scaling, image blur
4. Program using 1D, 2D, and 3D stencil operations.
5. Demonstrate convolution, scan and reduction
6. OpenMP thread-based programming
7. Calculation of pi using work sharing and reduction
8. Demonstrate producer consumer problem
9. Demonstrate Molecular dynamics simulation problem.
10. Calculate π - MPI Bcast and MPI Reduce
11. Solve ocean kernel, reduction problem
12. Perform matrix multiplication on a Cartesian grid using Cannon's algorithm

Textbooks:

1. Wen-Mei W Hwu, David B Kirk, Programming Massively Parallel Processors a Hands-on Approach (3ed.).Morgann Kaufmann, 2016
2. Rezaur Rahman, Intel Xeon Phi Coprocessor Architecture and Tools. Apress Open, 2013

References :

1. Gabriele Jost, Ruud van der Pas, Using OpenMP, Barbara Chapman. MIT Press, 2008.

CST316.6: Human-Computer Interaction Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will be able to

CO1 **Develop**[3] interfaces of interactive systems for the desktop, mobile and Web environment.

CO2 **Compare**[4] tasks in typical interactive systems, and apply predictive modeling and evaluation methods.

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Execution of Heuristic Evaluation Plan (HE Plan)
2. Execution of Heuristic Evaluation (Individual Evaluations)
3. Generation of Heuristic Evaluation Report (HE Report)
4. Execution of Thinking Aloud Test Plan (TA Plan)
5. Execution of Thinking Aloud Test (TA Videos)
6. Development of User Interface for Multiple Choice Test
7. Construction of paper prototypes with the help of Wireframe sketcher
8. Preparing Flash Presentation
9. Design an User Interface for calculator
10. Design an User Interface for simple sort program

Textbooks:

1. Alan Dix, “Human Computer Interaction”, Pearson Education, ISBN 978-81-317-1703-5, 3rd edition, 2008.
2. Gerard Jounghyun Kim, “Human Computer Interaction: Fundamentals and Practice”,

CRC Press, ISBN 978-1-4822-3390-2, 1st edition, 2015.

References :

1. Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, "About Face: The Essentials of Interaction Design (English)", 4th edition, 2014.
2. Don Norman, "The Design of Everyday Things", 2nd edition, 2013.

CST316.7 : Ethical Hacking Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will be able to

CO1 **Experiment**[5] emails exploitation and security.
CO2 **Examine**[3] attacks on operating systems.(Windows and Linux)

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. To experiment Email Servers-mail Forgery and Spamming.
2. To provide security to Anonymous Mailing, Attacks on E-mail Password.
3. To implement securing the E-Mail Passwords, Email Forensics.
4. To experiment Windows login, password and other security measures.
5. To experiment Linux login, password and other security measures.
6. To use steganography and backdoor types and tools.
7. To apply detection of Trojans, viruses and apply security.
8. To experiment registry tweaks and Tricks.
9. To apply Back-Track Penetration Tool.
10. To implement Secure Network Configuration

Textbooks:

1. Michael T. Simpson, Kent Backman, James E. “Corley, Hands-On Ethical Hacking and Network Defense”, Second Edition, CENGAGE Learning, 2010.

References :

1. Steven DeFino, Barry Kaufman, Nick Valenteen, “Official Certified Ethical Hacker Review Guide”, CENGAGE Learning, 2009-11-01.
2. Whitaker & Newman, “Penetration Testing and Network Defense”, Cisco Press,

Indianapolis, IN, 2006.

3. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy", Syngress Basics Series – Elsevier, August 4, 2011.

CST316.8 : Risk Assessment and Security Audit Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Data Structures

Course Outcomes: After the end of this course students will be able to

CO1 **Collect**[3] information for auditing.

CO2 **Assess**[5] Risk levels.

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines.
Project based assignments on following –

1. Identify risks in a software project
2. Identify laws and regulations for software contract
3. Collect data for software project audit
4. Analyze data for software project audit
5. Prioritize risks in software project
6. Create risk register for software process
7. Prepare audit plan
8. Perform sample audit
9. Prepare audit report

Textbooks:

1. Mark Talabis, “Information Security Risk Assessment Toolkit: Practical Assessments through Data Collection and Data Analysis”, Syngress 1st edition, ISBN: 978-1-59749-735-0, 2012.

References

1. David L. Cannon, “CISA Certified Information Systems Auditor Study Guide”, John Wiley & Sons, ISBN: 978-0-470-23152-4, 2009.

Sanjay Ghodawat University, Kolhapur

School of Technology

Department of Computer Science and Engineering

Structure and Contents for Third Year B. Tech. Computer Science and Engineering Program

(AY 2020-21) R0

AME/P/80/00

ST318 : Software Proficiency Program II							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	4	2	Practical	FEP	50	40
					POE	50	40

Prerequisite: Object oriented Programming Concepts

Course Outcomes: After the end of this course students will be able to

CO1 **Design**[5] dynamic web pages using Scripting languages, php, jsp

CO2 **Develop**[5] web pages using AngularJS

Contents

Four hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Create a web page with the following using HTML.
   To embed an image map in a web page.
   To fix the hot spots.
   Show all the related information when the hot spots are clicked
2. Create a web page with all types of Cascading style sheets.
3. Design the static web pages required for college website with css and host it on free domain
4. Implement a Java script program for displaying and comparing two dates
5. Design a HTML page including any required Java script that takes a number from one text field in the range of 0 to 999 and shows it in another text field in words. If the number is out of range, it should show “out of range” and if it is not a number, it should show “not a number” message in the result box.
6. Implement a Java script program for Form Validation including text field, radio buttons,

check boxes, list box and other controls.

7. Write programs in Java to create three-tier applications using JSP and Databases
   For conducting on-line examination.
   For displaying student mark list. Assume that student information is available in a database which has been stored in a database server.
8. Implement JSP which insert the details of the 3 or 4 users who register with the web site by using registration form. Authenticate the user when he submits the login form using the user name and password from the database.
9. Write a XML program for creating a cd catalog.
10. Write a XML program and DTD for a document
11. Design a web application using PHP that takes name and age from an HTML page. If the age is less than 18 it should send a page with "Hello, you are not authorized to visit this site" message, where should be replaced with the entered name. Otherwise it should send "Welcome to this site" message.
12. Design a web application using PHP for given statement: The user is first served a login page which takes user's name and password. After submitting the details the server checks these values against the data from a database and takes the following decisions. If name and password matches, serves a welcome page with user's full name.If name matches and password doesn't match, then serves "password mismatch" page If name is not found in the database, serves a registration page, where user's full name is asked and on submitting the full name, it stores, the login name, password and full name in the database (hint: use session for storing the submitted login name and password)
13. Create student registration form using angular js
14. Validate student registration form with reactive and template driven forms
15. Implement JWT-based authentication in Angular apps with the help of a simple Express server.
16. Incorporate animations in Angular 6 applications with the help of animation components and Bootstrap.
17. Deploy an App to Firebase with Angular CLI

Textbooks:

1. Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education, 2006.
2. Greg Lim, “Beginning Angular with Typescript (updated to Angular 6)”, Kindle edition

References :

1. Robert. W. Sebesta, "Programming the World Wide Web", Fourth Edition, Pearson Education, 2007 .
2. Deitel, Deitel, Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006.
3. Marty Hall and Larry Brown, “Core Web Programming”, Second Edition, Volume I and II, Pearson Education, 2001.
4. Bates, ―Developing Web Applications, Wiley, 2006
5. Chandermani Arora, “Angular 6 by Example: Get up and running with Angular by building modern real-world web apps”, 3rd Edition , Kindle Edition

CST320 : Mini Project							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	50	40
					POE	50	40

Prerequisite: Computer programming Language, Database Concepts, software engineering concepts, Operating System Concepts, Computer Network Concepts.

Course Outcomes: After the end of this course students will be able to

CO1 **Apply**[3] the engineering approach to solve the real time problems.

CO2 **Apply**[3] the skills of team building and team work.

Contents

The Mini Project work should be carried out by using free and Open source softwares. The students should form group of 3 to 4 students each and every group is supposed to choose a specific domain in which they would like to develop their expertise. Further, the group should identify the relevant problem and propose the solution, which can be implemented as a mini-project using suitable technology.

Students need to maintain a Project Diary and update the project progress, work reports in the project diary. Every student must submit a detailed project report in the format provided by the department. Periodic internal review shall be conducted which is evaluated by panel of examiners. The mini project work will be evaluated in the mid and end of the semester during which the group should give presentation and demonstration of their work done.

Evaluation of the mini project will be based on the following criteria:

Originality and Novelty
Project Scope, Objectives and Deliverables

Understanding of the Project Concept

Output of Results and Proper Documentation

Final Reports and Presentations

Two hours per week per batch practical is to be utilized for project work. Students should follow following sequence of activities :

1. Project topic and title finalization.
2. Submission of proposal for project work (Synopsis).
3. First presentation which includes a) Requirements analysis b) Architecture c) Data design d) Algorithm design e) Module identification f) Class properties d) Method identification. If applicable) g) Level 0 & Level 1 DFD h) Object oriented analysis (UML diagrams).
4. Second presentation.
5. End Semester Review in 3rd Presentation (after 100 % implementation of all modules).
6. Project report preparation.

Textbooks:

1. Pankaj Jalote, Software Engineering : A precise Approach, Wiley India, 2010.
2. Yashvant Kanetkar, Let Us C, BPB Publications, 2016.

References :

1. Paul Cobbaut, Linux Fundamentals, CEST, 2015.

CST322 : Internship Training							
Ver 1.0, Project Work, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	-	1	Project	FEP	100	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will be able to

CO1 **Demonstrate**[3] communication, interpersonal skills

CO2 **Apply**[3] theoretical concepts to field work

Contents

Students are required to undergo internship of ***three*** **weeks** during vacation at the end of semester V and the same will be evaluated in semester VI.

The aim of this course is to use the internship experience to enable students to develop their engineering skills and practice. The students will be assessed for academic credit. The internships should be aligned with computer science and engineering program and its areas of specialization. Students will experience a real-life engineering workplace and understand how their engineering and professional skills and knowledge can be utilized in industry. They will also be able to demonstrate functioning engineering knowledge, both new and existing, and identify areas of further development for their future careers.

CST324 : Foreign Language Part I Ver. 1.0, Mandatory Course, School of Technology							
Lect.	**Tut.**	**Pract.**	**Credits**	**Evaluation Scheme**			
				Component	**Exam**	**Weightage**	**Pass %**
2	-	-	Au	Theory	FET	100	40

Prerequisite: Nil

Contents

Theory

Lesson 1- Managing conversation
Lesson 2- Months and days of week
Lesson 3- Numbers
Lesson 4- Time
Lesson 5- Asking for Telephone number
Lesson 6- Directions
Lesson 7- Everyday life
Lesson 1- Map of Germany
Lesson 2- Countries and Nationalities
Lesson 3- Family

Grammar

Lesson 1- Alphabets
Lesson 2- German nouns
Lesson 3- Nominative case
Lesson 4- Negation
Lesson 5- Pronouns - nominative case
Lesson 6- Regular verb and their conjugation
Lesson 7- Irregular verbs
Lesson 1- Possessive pronouns
Lesson 2- Interrogative pronouns
Lesson 3- Demonstrative pronouns

CST315.8 : Digital Forensics Laboratory							
Ver 1.0, Program Vertical, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	100	40

Prerequisite: Nil

Course Outcomes: After the end of this course students will be able to

CO1 Experiment[3] with problems related to cybercrime

CO2 Experiment[3] with different issues related to Forensic Duplicates.

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Implement Incident Response Methodology
2. Program to demonstrate a Forensic.
3. Program to Implement Initial Response & Volatile Data Collection from Unix system
4. Program to Implement Forensic Duplicates as Admissible Evidence
5. Program to implement Hard Drives Evidence Handling
6. Program to implement Evidence handling procedure.
7. Program to Implement Different Attacks in network
8. Program to Implement Email Tracing
9. Program To detect Internet Fraud
10. Program to Investigate Live Systems (Windows & Unix)
11. Program to understand Internet Fraud

Textbooks:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill, 2006
2. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001

References :

1. Skoudis. E., Perlman. R., “Counter Hack: A Step-by-Step Guide to Computer Attacks and Effective Defenses”, Prentice Hall Professional Technical Reference. 2001
2. Norbert Zaenglein, "Disk Detective: Secret You Must Know to Recover Information From a Computer", Paladin Press, 2000.
3. Bill Nelson, Amelia Philips and Christopher Steuart, “Guide to computer forensics investigation”, Cengage learning, 4th edition, 2013

CST317 : Software Proficiency Program I							
Ver 1.0, Program Core, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
-	-	2	1	Practical	FEP	50	40
					POE	50	40

Prerequisite: Object oriented Programming Concepts

Course Outcomes: After the end of this course students will be able to

CO1 **Make use of**[3] data structures, object oriented programming and database concepts to develop application in python

CO2 **Write**[3] functions in R

Contents

Two hours per week per batch practical is to be utilized for writing programs to ensure that students have properly learnt the topics covered in the lectures. It should comprise of minimum 10-12 experiments. Students of different batches should implement different programs based on the following guidelines-

1. Introduction to Python
2. Setup
3. Working in a python shell
4. Lists, Tuples, Dictionaries
5. Mutable Immutable Objects
6. Basic I/O
7. String methods, Iterator, Conditionals, Loops
8. Object Oriented Techniques(Modules, Classes and Objects)
9. Standard libraries- os, itertools, copy, math, re, requests
10. Extracting social media data using Python
11. Introduction to Qt architecture
12. Introduction to Qt designer
13. Create a login and Student Registration Form using pyQt and oracle
14. Show data into QTableWidget from database
15. Study of R-declaring variables, expressions, functions and executing R script.
16. Working with R with data sets- create, read, write and R Tables- create, read, write

17. Manipulating and processing data in R- merging datasets, sorting data, putting data into shape, managing data using matrices managing data using data frames.

Textbooks:

1. Charles R. Severance, "Python for Everybody: Exploring Data using Python 3",1st edition, CreateSpace Independent Publishing Platform, 2016,(http://do1.dr-chuck.com/pythonlearn/EN_us/pythonlearn.pdf)(chapters 1-13,15)
2. Sandeep Rakshit, "R for beginners", Mcgraw Hill, ISBN: 9789352604555, 9352604555,Edition: 1, 2017,Pages:424, Manav Book Distributors

References :

1. Allen B.Downey, "Think python: How to Think like a computer Scientist" 2nd edition, Green Tea Press,2015

CST319 : Scholastic Aptitude							
Ver 1.0, Mandatory Course, School of Technology							
Lect.	Tut.	Pract.	Credits	Evaluation Scheme			
				Component	Exam	Weightage	Pass %
3	-	-	Au	Theory	FET	100	40

Syllabus

Vedic Maths :

1. 2 by 2 subtraction
2. 2 by 2 multiplication
3. Finding square of larger number quickly
4. To find table only within 5 sec

Calendar : Special formulated speedy way of calculating calendars i.e. to find date in calendar within 5 to 10 sec

Ratio Proportion :

1. Ratio.
2. Proportion.
3. Mean Proportional
4. Direct Proportion
5. Inverse proportion

Percentage :

1. Percentage fraction conversion table
2. Percentage conversion in decimal method

Blood relation :

1. Blood relation By simple Relation method
2. Blood relation by coded method

Direction sense :

1. Concept Clarity
2. Problems based on distance
3. Problems based on directions
4. Pythagoras Theorem
5. Quick Method

Profit and Loss :

1. Basic Concepts
2. Various Prices
3. Key Terms

4. Study different Types of problems
5. Solving Problems

Time rate work, Pipes and Tanks :

1.Concept of Time, Rate, Work
2.Negative Work
3.Template of problem Solving
4.Faster method to solve problems

Simple interest and Compound interest :

1. Meaning of Interest
2. Simple Interest Formula
3. Ratio Approach for problem Solving
4. Compound Interest Formula
5. Concept Of Depreciation

Average :

1. Average question on ages
2. Average questions on replacement

Speed, Time and Distance. Train, Race, Boat Stream :

1.Basic Formula of Speed,Time and Distance
2.Concept of trains & boats
3.Upstream downstream
4.Application of LCM method & relative motion

Permutation, Combination and Probability :

1.Concept Of Arrangement
2.Concept of Selection
3.Shortcut Probability methods
4.Application of Probability in dice,coin ,card and ball.

Syllogism :

1.Logical Deduction
2.Merging Concept
3.Positive & Negative Relation
4.Syllogistic Reasoning

Seating arrangements :

1. Circular Arrangement problems.
2. Linear Arrangement problems.
3. Square/Rectangular Arrangement(inward, outward, both side facing)
4. Combination of all Above