WALCHAND COLLEGE OF ENGINEERING SANGLI

(An Autonomous Institute)

Curriculum (Structure and Syllabus)

for

Second Year B.Tech

Computer Science and Engineering

Academic Year 2019-2020

Walchand College of Engineering, Sangli.

(An Autonomous Institute)

Teaching and Evaluation Scheme effective from 2019-2020

Second Year B. Tech. Program in Computer Science and Engineering

Semester I

Course			Teaching Scheme				Evaluation Scheme			
Category	Code	Name	L	T	P	Credits	Component	Marks		
								Max	Min for Passing	
BS	4CS201	Applied Mathematics for Computer Science and Engineering	3	0	0	3	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
HS	4HS203	Environmental Science	2	1	0	3	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
PC	4CS202	Discrete Mathematics	3	1	0	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
PC	4CS203	Data Structures	3	0	0	3	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
PC	4CS204	Data Communication	3	0	0	3	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
PC	4CS205	Computer Organization and Architecture	3	0	0	3	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
PC	4CS251	Data Structures Laboratory	0	0	2	1	ISE	50	20	
							ESE	50	20	
PC	4CS252	Computer Organization and Architecture Laboratory	0	0	2	1	ISE	50	20	
							ESE	50	20	
PC	4CS253	Programming Laboratory I	0	0	4	2	ISE	50	20	
							ESE	50	20	
Total			17	2	8	23	**Total Credits: 23** **Total Contact Hrs.: 27**			

Ms. A. S. Pawar

07/06/19

DR. B. F. MOMIN

Associate Professor & Head

Dept. of Computer Science & Engineering

Walchand College of Engineering,Sangli

Walchand College of Engineering, Sangli

(An Autonomous Institute)

Teaching and Evaluation Scheme effective from 2019-2020

Second Year B. Tech. Program in Computer Science and Engineering

Semester II

Course			Teaching Scheme				Evaluation Scheme		
Category	Code	Name	L	T	P	Credits	Component	Marks	
								Max	Min for Passing
HS	4HS201/ 4HS202	Development of Societies/Philosophy	2	0	0	2	ISE 1	10	40
							MSE	30	
							ISE 2	10	
							ESE	50	20
PC	4CS221	Software Engineering	3	0	0	3	ISE 1	10	40
							MSE	30	
							ISE 2	10	
							ESE	50	20
PC	4CS222	Formal Language and Automata Theory	3	1	0	4	ISE 1	10	40
							MSE	30	
							ISE 2	10	
							ESE	50	20
PC	4CS223	Operating Systems	3	0	0	3	ISE 1	10	40
							MSE	30	
							ISE 2	10	
							ESE	50	20
PC	4CS224	Database Engineering	3	0	0	3	ISE 1	10	40
							MSE	30	
							ISE 2	10	
							ESE	50	20
PC	4CS225	Computer Network	3	0	0	3	ISE 1	10	40
							MSE	30	
							ISE 2	10	
							ESE	50	20
PC	4CS271	Database Engineering Laboratory	0	0	2	1	ISE	50	20
							ESE	50	20
PC	4CS272	Computer Network Laboratory	0	0	2	1	ISE	50	20
							ESE	50	20
PC	4CS273	Programming Laboratory 2	0	0	4	2	ISE	50	20
							ESE	50	20
Total			17	1	8	22	**Total Credits: 22** **Total Contact Hrs.: 26**		

Ms. A. S. Pawar

01/06/19

DR. B. F. MOMIN
Associate Professor & Head
Dept. of Computer Science & Engineering
Walchand College of Engineering,Sangli

Title of the Course: Applied Mathematics for Computer Science and Engineering **Course Code: 4CS201**	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Engineering Mathematics I and Engineering Mathematics II

Textbooks:
1. Gilbert Strang, "Linear Algebra and its applications", Cengage Learning, 4th edition, 2014.
2. George J. Klir and Bo Yuan, " Fuzzy Sets and Fuzzy Logic : Theory and Applications", Prentice Hall PTR, 1995.
3. Timothy C. Urdan, " Statistics in Plain English", Routledge-Taylor and Fransis Group, 3rd Edition, Volume 1, 2010.

References:
1. Seymour Lipschutz and Mark Lipson,"Schaum's outlines of Theory and Problems of Linear Algebra", Tata McGraw Hill, 3rd Edition, 2007.
2. William Stein, "Elementary Number Theory: Primes, Congruences, and Secrets", Springer, 1st Edition, 2008.

Course Objectives :
1. To understand the mathematical theory of Linear Algebra, Probability and Statistics for computer science engineers.
2. To develop skills necessary to solve practical problems in cryptography, data science and machine learning.
3. To understand the properties, operations and relations on Fuzzy sets.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	To illustrate the concept of Linear Algebra and Fuzzy sets with case studies.	2	Understanding
CO2	To apply mathematical and statistical tools for data analysis	3	Applying
CO3	To identify and solve mathematical problems using tools from mathematical areas, including algebra, analysis, statistics and number theory.	3,4	Applying, Analyzing

CO-PO Mapping : (Use 1,2,3 as correlation strengths)

PO	1	2	3	4	5	6	7	8	9	10	11	12	13(PSO1)	14(PSO 2)
CO1	2													
CO2	3				1								3	
CO3		3		2										

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Module 1 Vector Spaces Introduction, Vector spaces, Linear combinations, Spanning sets, Subspace, Linear dependence and independence, Basis and dimension, Null space, Column space, Row space, Rank-Nullity theorem.	**6 Hrs.**
Module 2 Advanced Concepts in Linear Algebra Vector dot product, Inner product space, Length and orthogonality, Orthogonal sets, Orthonormal sets, Orthogonal projections, Gram-Schmidt Process, Least square problems, Applications and significance of Eigen values and Eigen vectors.	**7 Hrs.**
Module 3 Fuzzy Sets Introduction to characteristics functions, First decomposition theorem, Fuzzy relations, examples, Fuzzy equations, Operations on Fuzzy sets.	**7 Hrs.**
Module 4 Exploratory Data Analysis Discrete and continuous random variables, PDF, CDF, percentile, Inter quartile range, central tendency (mean, mod, median, dispersion, skewness, kurtosis), variance, standard deviation, Mean Absolute Deviation (MAD), Standardization (Z-score), Normalization.	**6 Hrs.**
Module 5 Topics in probability and statistics Sampling Distributions, Central limit theorem, Single and multivariate: Confidence Interval, Correlation, Causation, Covariance, Prearson's correlation coefficient, resampling and permutation.	**7 Hrs.**
Module 6 Number theory Primality Testing: Primality Tests, Pseudo primes, Fermat's pseudo primes, Factorization techniques, Multiplicative inverse. Euclidean algorithm, Chinese remainder theorem, Fermat's little theorem, Wilson's theorem, Primitive roots, Quadratic residues.	**7 Hrs.**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. **Module 1:** Solve the problems on vector spaces.
2. **Module 2:** Apply the core concept of Linear Algebra to real life applications.
3. **Module 3:** Explain the knowledge of fuzzy set and system through set theory.
4. **Module 4:** Visualize and understand the different data from science and engineering domains using statistics tools.
5. **Module 5:** Make use appropriate statistical methods in the analysis of simple datasets.
6. **Module 6:** Identify how number theory is related to and used in cryptography.

Title of the Course: Applied Mathematics for Computer Science and Engineering **Course Code:** 4CS201	L	T	P	Cr
	3	0	0	3

Desirable requirements: Engineering Mathematics I and Engineering Mathematics II

Textbooks:

Textbooks:

1. Gilbert Strang, "Linear Algebra and its applications", Cengage Learning, 4th edition, 2014
2. George J. Klir and Bo Yuan, " Fuzzy Sets and Fuzzy Logic : Theory and Applications", Pearson Education Services Pvt. Ltd., 4th edition, 2017
3. Timothy C. Urdan, " Statistics in Plain English", Routledge-Taylor and Fransis Group, 3rd Edition, Volume 1, 2010

References:

1. Seymour Lipschutz and Mark Lipson,"Schaum's outlines of Theory and Problems of Linear Algebra", Tata McGraw Hill, 3rd Edition, 2007.
2. William Stein, "Elementary Number Theory: Primes, Congruences, and Secrets", Springer, 1st Edition, 2008.

Course Objectives: The main objective of this course is to build a foundation for solving problems in different domains such as Machine Learning, Artificial Intelligence, Scientific Computing, Cryptography etc. The objectives are further divided as:

1. To infuse an understanding of the mathematical theory of Linear Algebra, Probability and Statistics for computer science engineers.
2. To provide a foundation to solve practical problems in cryptography, data science and machine learning.
3. To give insights about the properties, operations and relations on Fuzzy sets.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Illustrate** the concept of Linear Algebra and Fuzzy sets with case studies.	2	Understanding
CO2	**Apply** mathematical and statistical tools for data analysis	3	Applying
CO3	**Solve** mathematical problems using tools from mathematical areas, including algebra, analysis, statistics and number theory.	3	Applying

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	-	3	-	-	-	-	-	-	-	-	-	3	-

1: Low, 2: Medium, 3: High

13/06/19
N.K. Pikle

13/06/19
Ms. Yadav P.P.

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/oral etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Vector Spaces	**6 Hrs.**
Introduction, Vector spaces, Linear combinations, Spanning sets, Subspace, Linear dependence and independence, Basis and dimension, Null space, Column space, Row space, Rank-Nullity theorem.	
Module 2 Advanced Concepts in Linear Algebra	**7 Hrs.**
Vector dot product, Inner product space, Length and orthogonality, Orthogonal sets, Orthonormal sets, Orthogonal projections, Gram-Schmidt Process, Least square problems, Applications and significance of Eigen values and Eigen vectors.	
Module 3 Fuzzy Sets	**7 Hrs.**
Introduction to characteristics functions, First decomposition theorem, Fuzzy relations, examples, Fuzzy equations, Operations on Fuzzy sets.	
Module 4 Exploratory Data Analysis	**6 Hrs.**
Discrete and continuous random variables, PDF, CDF, percentile, Inter quartile range, central tendency (mean, mod, median, dispersion, skewness, kurtosis), variance, standard deviation, Mean Absolute Deviation (MAD), Standardization (Z-score), Normalization.	
Module 5 Topics in probability and statistics	**7 Hrs.**
Sampling Distributions, Central limit theorem, Single and multivariate: Confidence Interval, Correlation, Causation, Covariance, Prearson's correlation coefficient, resampling and permutation.	
Module 6 Number theory	**7 Hrs.**
Primality Testing: Primality Tests, Pseudo primes, Fermat's pseudo primes, Factorization techniques, Multiplicative inverse. Euclidean algorithm, Chinese remainder theorem, Fermat's little theorem, Wilson's theorem, Primitive roots, Quadratic residues.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1:

- Solve the problems on vector spaces.

Module 2:

- Apply the core concept of Linear Algebra to real life applications.

Module 3:

- Illustrate the knowledge of fuzzy set and system through set theory.

Module 4:

- Visualize and understand the different data from science and engineering domains using statistics tools.

13/06/19
N.K. Pikle

13/06/19
Ms. Yadav P.P.

Module 5: • Make use of appropriate statistical methods in the analysis of simple datasets. **Module 6:** • Identify how number theory is related to and used in cryptography.

13/06/19
N. K. Pikle

13/06/19
Ms. Yadav P. P.

Title of the Course: **Environmental Science** Course Code: 4HS203	L	T	P	Cr
	2	1	0	3

Pre-Requisite Courses: Nil

Textbooks:

1. Mrinalini Pande, "Disaster Management", Wiley Publications New Delhi, First edition, 2014
2. N.K Uberoi, "Environmental Studies", Excel Books Publications New Delhi, first edition, 2005
3. R.Rajagopalan, "Environmental Studies from crisis to cure" Oxford university press, second edition, 2011

References:

1. William. Cunningham and Barbara Woodworth Saigo, "Environmental Science: A Global Concern", WCB/McGraw Hill publication, 5th Edition, 1999
2. Peter. H. Raven, Linda. R. Berg, George. B. Johnson, "Environment", McGraw Hill publication, 2nd -Edition, 1998
3. Catherine Allan & George H. Stanley (Editors), "Adaptive Environmental Management", Springer Publications. 2009

Course Objectives :

1. Infuse an understanding of the various environmental concepts on scientific basis in the functional area of Engineering and technology.
2. Provide a foundation to critically assess the approaches to pollution control, environmental and resource management, sustainable development, cleaner technologies, Environmental Legislation based on an understanding of the fundamental, environmental dimensions.
3. Inculcate the modern concept of green industry and the impact of excess human population, globalization, and climate change on the environment.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO1	Describe key concepts of Environmental science and their relationship to engineering.	2	Understanding
CO2	Explain ethical and legal responsibility of an engineer and his role in effective implementation of sustainable activities through EIA and EMS in the corporate sector.	2	Understanding
CO3	Predict impact of contemporary issues (Population Explosion, Climate change, Environmental pollution) on the environment.	2	Understanding

CO-PO Mapping : (Use 1, 2, 3 as Correlation Strengths)

PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1						2	2							
CO2							3	2						
CO3							2							

(M.S. Ali)

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Environment, Ecology and Biodiversity	**Hrs.**
Introduction: Natural and Built Environment, Environmental education: definition, scope, objectives and importance, Components of the Environment: Atmosphere, Hydrosphere, Lithosphere and Biosphere. Ecology : Introduction, Types (terrestrial and aquatic ecosystems) , Structure and function, Trophic levels, Food chains, food webs, Ecological pyramids, Ecological succession, Biogeochemical cycles. Biological Diversity: Introduction, Value of biodiversity: consumptive use, Threats to biodiversity, Conservation of biodiversity.	7
Module 2: Human Population, Energy and Natural Resources	**Hrs.**
Human Population Growth and Environment: Population Dynamics, Age structures, Energy Scenario: Future projections of Energy Demand, Utilization of various Energy Sources, Conventional Energy Sources and Non- Conventional Energy Sources, Urban problems related to energy. Natural Resources: Food, Water, Forest, Geological, Equitable Use of Resources for Sustainable life style. Case studies.	5
Module 3: Climate Change, Environmental Quality and Pollution Control	**Hrs.**
Climate change: Global warming, Ozone depletion, Acid Rain. Environmental Impact: Impact of Modern agriculture on the Environment, Impact of Mining on the Environment, Impact of Large dams on the Environment, Environmental pollution: Air, Water, Soil, Noise, Marine, classification of pollutants, their causes, effects and control measures. Case studies.	5
Module 4: Solid, Hazardous Waste and Disaster Management	**Hrs.**
Solid and Hazardous waste management: Introduction, categories, causes, effects and management of municipal solid waste, Hazardous waste Disaster Management: Introduction, types of disasters, Disaster mitigation. Case studies.	4
Module 5: Social Issues, Environmental Management and Legislation	**Hrs.**

(M.S.Ali)

Environmental ethics: Introduction, Ethical responsibility, issues and possible solutions. Environmental Management: Introduction to Environmental Impact Assessment, Environmental Management System: ISO 14001Standard, Environmental Auditing, National and International Environmental protection Agencies pertaining to Environmental Protection. Environmental Legislation: Environmental protection act 1986, Water (prevention and control of pollution) Act 1974, Air (prevention and control of pollution) Act 1981, Wild life Protection Act 1972, and Forest Conservation Act 1980. Municipal Solid Wastes (Management and Handling) Rules, 2000.	4
Module 6: Cleaner technology	**Hrs.**
Restoration Ecology, Role of Information Technology in Environment science, Green buildings, Green products, Consumerism and Waste Products, Minimization of Hazardous Products, Reuse of Waste, By-products, Rainwater Harvesting, Translocation of trees. Some Success Stories. Case studies	3
Module wise Outcomes At end of each module students will be able to **Module 1:** • Determine an in-depth understanding of the interdisciplinary relationship of cultural, ethical, and social aspects of local/global environmental issues. Understand how interactions between organisms and their environments drive the dynamics of individuals, populations, communities, and ecosystems. **Module 2:** • Describe the impact of human population on the environment, and the utilization of natural resources for sustainable life style. **Module 3:** • Explain the issues like Climate change, Global warming, Global Warming Potential, Ozone depletion, Ozone depletion Potential, Impact of Modern agriculture on the Environment, Impact of Mining on the Environment, Impact of Large dams on the Environment, Bio magnification, Eutrophication and apply learned information to postulated environmental scenarios to predict potential outcomes. **Module 4:** • Identify and define different disasters and their mitigation in addition to solid and hazardous waste management. **Module 5:** • Sense the legislation governing environmental research and the environment. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems. **Module 6:** • Describe strategies, technologies, and methods for assessment and sustainable management of environmental systems and for the remediation or restoration of degraded environments.	
Tutorial: The tutorials consist of Quiz, Tests, Assignments in addition to a mini project work based on diverse environmental issues and topics.	

(M.S. Ali)

Title of the Course: Discrete Mathematics Course Code: 4CS202	L	T	P	Cr
	3	1	0	4

Desirable requirements: Mathematics-(set theory, Boolean operations, logical operations)

Textbooks:

1. J.P. Tremblay &R. Manohar , "Discrete Mathematical structure with applications to computer", McGraw Hill,1st Edition, 2001
2. Liu, "Elements of Discrete Mathematics", Tata McGraw Hill,3rd edition 2008
3. Kenneth Rosen, "Discrete Mathematics & its application" McGraw Hill, 7th edition 2012.

References:

1. K.D. Joshi, "Foundation of Discrete Mathematics", New Age International Ltd,1st edition,2014
2. Seymour Lipschutz , Marc Lipson "Discrete Mathematics: Schaum's Outlines Series", Schaum's outline series.,3rd edition, 2009

Course Objectives : This subject enhances one's ability to reason and ability to present a coherent and mathematically accurate argument. About 30% of the course time will be spent on logic, set theory, counting techniques and remaining 60% of the course time will be devoted to functions, relations, algebraic structures, graph theory, permutation and combination. Objectives of this course are as follows:

1. Deliver basic concepts of Logic theory to solve real life problems.
2. Introduce graphs, trees and algebraic structure and develop an attitude to solve problems based on these topics.
4. To give deep insight into discrete probability and combinatorics.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** logical notation to define and reason about fundamental mathematical concepts of logic theory, set theory, relations, probability, counting techniques.	2	Understanding
CO2	**Demonstrate** knowledge and skills obtained to investigate and solve problems of POSET, Hasse diagram, groups, semi group and monoid.	3	Applying
CO3	**Analyse** concepts and algorithms of graph theory and elementary combinatorial processes such as permutations and combinations.	4	Analysing

CO-PO Mapping :

PO and PSO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	1	-

1: Low, 2: Medium, 3: High

Ms. A.V. Teekhedkar

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on quiz/assignments.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Mathematical Logic & Set Theory	**6 Hrs.**
Introduction, Statement and Notation, Connectives, statements formulas and truth tables, well-formed formulas, Tautologies Equivalence of formulas, Tautologies, other connectives, Normal & Principal Normal forms. Basic concepts of set theory, Venn Diagram, set operation, algebra of sets.	
Module 2 Relations and Functions	**7 Hrs.**
Relations, Pictorial representation of Relations, Properties of binary relation, Equivalence Relations, partition and covering of set, POSET and Hasse Diagram, Functions - types, Inverse and composition of functions, lattice.	
Module 3 Algebraic structures	**6 Hrs.**
Introduction, Operations, semigroups, Groups, subgroups, Rings, monoid.	
Module 4 Graph theory and its applications	**7 Hrs.**
Basic terminology, multigraphs and weighted graphs, Paths and Shortest path in weighted graphs, Hamiltonian and Eulerian Paths and Circuits, Factor of a graph, Planner Graph.	
Module 5 Directed graphs	**6 Hrs.**
Trees, Rooted Trees, Path lengths in rooted trees, Prefix codes, Binary search trees, Spanning trees and cut sets, Minimal spanning trees, Kruskal's algorithm and Prim's algorithms, Warshall's algorithm for transitive closure.	
Module 6 Permutation, Combination and Discrete Probabilities	**7 Hrs.**
Basic counting techniques – inclusion and exclusion, Rules of sum and product, permutations, combinations, generation of permutations and combinations, Introduction to Discrete Probability, entropy and mutual information, recursion.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1:

- Able to construct and explain logical proofs as logic plays a major role in formal languages and in hardware and software.

Module 2:

- Grasp concepts of relations and functions and demonstrate skills to solve related problems.

Module 3:

- Identify different algebraic structures

Module 4:

- Apply graph application in computer domain- e.g. finding shortest path in networking etc.

Ms. A. V. Teekhedkar

Module 5:

- Analyse concepts of trees, minimum cost spanning trees using different types of algorithms.

Module 6:

- Solve problems on permutation, combination and probability.

Tutorials: Group work solutions for Problems based on:

1. CNF, DNF, set theory, Venn Diagrams.
2. Equivalence relation, binary relation.
3. POSET and HASSE diagrams.
4. Algebraic structures.
5. Graph, Shortest path in weighted graphs ,Hamiltonian and Eulerian Paths and Circuits
6. Real Time Application of graph theory.
7. Warshall's Algorithm, prims and Kruskal's algorithm
8. Finding out optimal solution based on graph theory and trees.
9. Permutation and combination.

Ms. A. V. Jeekhedkar

Title of the Course: Data Structures **Course Code:** 4CS203	L	T	P	Cr
	3	0	0	3

Desirable requirements: Programming in C including pointers and File Handling

Textbooks:

1. Richard F. Gilberg, Behrouz A. Forouzan, "Data Structures, A Pseudocode Approach With C",Cengage Learning, Second Edition, 2014
2. S. Lipschutz, "Data Structures,Schaum's" Outlines Series, Tata McGraw-Hill, 2013
3. Ellis Horowitz, S. Sahni, D. Mehta, "Fundamentals of Data Structures in C++", Galgotia Book Source, New Delhi, 2008

References:

1. Yashavant Kanetkar, "Understanding pointers in C", BPB Publication, 4th Edition, 2009
2. N. B. Venkateshwarlu, E. V. Prasad, "C and Data Structures", S. Chand and Company, 2010
3. Jean-Paul Tremblay, Paul. G. Soresan, "An introduction to data structures with Applications", Tata Mc-Graw Hill International Editions, 2nd edition, 1984

Course Objectives :

This course is one of the core subject for Computer Science and Engineering students. The course mainly focuses on introducing various linear and nonlinear data structures, their characteristics and applications. The insight knowledge of various searching and sorting techniques enables the students to identify and apply suitable technique for different applications.

1. To make the students understand elementary linear and non-linear data structures and concepts of ADTs.
2. To develop and improve logical thinking and to make the students capable of applying appropriate data structure for modelling a given problem.
3. To provide a foundation to analyse and compare various searching and sorting techniques and to select appropriate technique to solve the problem.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Explain** the fundamental concepts of structuring, managing and organizing the data using linear and non-linear data structures with ADTs, write recursive algorithms and explain various searching and sorting techniques	2	Understanding
CO2	**Choose** suitable data structure to be used and apply it to solve the various problems	3	Applying
CO3	**Compare** and **Analyze** various algorithms, searching and sorting methods based on inherent properties of data structures and the complexity of algorithms.	4	Analyzing

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	3	-

1: Low, 2: Medium, 3: High

Dr. N. L. Gavankar

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on declared test/quiz/seminar
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction	**6 Hrs.**
Basic Concepts: Algorithm, Pseudocode, ADT, Data Structure, Algorithmic Efficiency **Recursion:** Direct and Indirect recursion, analysis of recursive functions e.g. Towers of Hanoi, Ackerman's function, etc.	
Module 2: Linked Lists	**6 Hrs.**
Concept of linked organization, Singly linked list, doubly linked list and dynamic storage management, circular linked list, Operations such as insertion, deletion, inversion, concatenation, computation of length, traversal on linked list, Representation and manipulations of polynomials using linked lists.	
Module 3: Stacks and Queues	**6 Hrs.**
Fundamentals stack and queue as ADT, Representation and Implementation of stack and queue using sequential and linked organization, Circular queue: representation and implementation, Application of stack for expression evaluation and for expression conversion, Backtracking, Stacks and Recursion, Priority queue Doubly Ended Queue.	
Module 4: Trees	**7 Hrs.**
Basic terminology, binary trees and its representation, binary tree traversals (recursive and non-recursive), operations such as copy, equal on binary tree, expression trees, AVL Tree, Binary Search Trees, Heaps and its operations, Introduction to Multiway Trees.	
Module 5: Graphs	**5 Hrs.**
Terminology and Representation of graphs using adjacency matrix, adjacency list and adjacency Multilist, Traversals Depth First and Breadth First, Minimum Spanning Tree.	
Module 6: Searching & Sorting Technique	**9 Hrs.**
Search: Importance of searching, Sequential, Binary, Fibonacci search algorithms **Sorting:** Internal and External Sorts, Insertion, Shell, Heap, Quick sort, Merge sort, Radix sort, Two-way merge sort **Hashing:** Hashing functions, overflow handling with and without chaining, open addressing: linear, quadratic, double, rehashing **Introduction to Files and Indexes** (concept only implementation not expected): Indexing Techniques: hashed indexes, Tree indexing - B-trees File Organizations: Sequential, Random and Linked organizations.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1:

- Explain ADT, build logic to solve the problem, write algorithms and think recursively.

Module 2:

- Apply concept of linked list and use of ADTs to solve the problem

Dr. N. L. Gavankar

Module 3:

- Choose data structures such as stacks and queues as the programmers' tool to solve problems.

Module 4:

- Apply non-linear data structure, tree and its basic operations and use it to solve the problem.

Module 5:

- Explain and use graph as a data structure to store and manipulate data for various applications

Module 6:

- Explain hashing, file organizations and compare various searching and sorting techniques.

Dr. N.L. Gavankar

Title of the Course: Data Communication Course Code: 4CS204	L	T	P	Cr
	3	0	0	3

Desirable Requirements : Nil

Textbooks:

1. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw-Hill, 4th/5th Edition, 2017.
2. William Stallings, "Data and Computer Communications", Prentice Hall(PHI) , 8th /9th Edition, 2010/2011

References:

1. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Pearson Education,5th /7th edition, 2012/2016

Course Objectives: The objective of the course is to provide a foundation and clear understanding of various concepts of data communication which will form basis of computer networking. Objectives are further divided as:

1. To elaborate various features and operations of data communication.
2. To inculcate protocol functions and issues related to Data Link layer.
3. To introduce the design and configuration of various networking techniques.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Describe** fundamental concepts of data communication system.	2	Understanding
CO2	**Interpret** various concepts related to data link layer protocols.	3	Applying
CO3	**Differentiate** and **analyze** various data communication techniques	4	Analyzing

CO-PO Mapping :

PO and PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	1	-	-	-	-	-	-	-	-	-	-	-

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

4/6/19 P. Dornadula

Course Contents:

Module 1: Introduction	**4 Hrs.**
A Communications Model, Data Communications, Networks, The Internet-An Example Configuration. Data communication Concepts and Terminology: Analog and Digital Data Transmission, Transmission Impairments, Channel Capacity. Media: Guided Transmission Media, Wireless Transmission, Wireless Propagation, Line-of-Sight Transmission Types of electronics communication, Electromagnetic spectrum, Bandwidth, Signal Types, Noise: internal, External, Noise calculation.	
Module 2: Encoding techniques	**8 Hrs.**
Digital Data- Digital Signals, Digital Data- Analog Signals, Analog Data- Digital Signals, Analog Data- Analog Signals. Digital data communication techniques:- Asynchronous and Synchronous Transmission, Types of Errors, Error Detection & Correction, Hamming Code, CRC, Checksum, Line Configurations, Numerical problems on encoding.	
Module 3: Multiplexing	**8 Hrs.**
Frequency Division Multiplexing, Synchronous Time Division Multiplexing, Statistical Time Division Multiplexing, Pulse code modulation, Delta modulation, Adaptive delta modulation, Differential PCM, PAM. Spread Spectrum: The Concept of Spread Spectrum, Frequency-Hopping Spread Spectrum, Direct Sequence Spread Spectrum, Code Division Multiple Access.	
Module 4: Switching techniques	**8 Hrs.**
Switched Communications Networks, Circuit-Switching Networks, Circuit-Switching Concepts, Soft switch Architecture, Packet-Switching Principles, X.25, and Frame Relay. Introduction to Asynchronous Transfer mode protocol Architecture, Logical Connections, ATM Cells, Routing in Arpanet.	
Module 5: Congestion control	**5 Hrs.**
Effects of Congestion, Congestion Control, Traffic Management, Frame Relay Congestion Control. Cellular wireless network: Principles of Cellular Networks, First-Generation Analog Second-Generation CDMA, Third-Generation Systems.	
Module 6: Flow Control and Internet Reference Models	**6 Hrs.**
Framing –Fixed, Variable error control, Flow control, Simplest Protocols, Stop & Wait Protocols, GO Back N & Selective Repeat Sliding window protocols, Numerical problems on flow control techniques, other Protocols. Internet and Reference models-OSI, TCP/IP.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1 :

- Describe Data Communication model and various media for communication

Module 2 :

- Differentiate different encoding techniques.
- Apply error control techniques.

Module 3 :

- Differentiate and analyze various multiplexing techniques.

Module 4 :

- Distinguish between different switching techniques.

Module 5 :

- Identify and describe congestion control mechanisms and cellular wireless network.

Module 6 :

- Describe and differentiate various flow control techniques.

4/6/19 PDM

Title of the Course: Computer Organization and Architecture Course Code : 4CS205	L	T	P	Cr
	3	0	0	3

Desirable requirements: Basic Electronics Engineering

Textbooks:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson Education, 8th Edition/10th Edition, 2010/2016
2. Ramesh S. Gaonkar, "Microprocessor architecture, programming & applications", Penram International publications (India) Pvt. Ltd, 6th edition, 2013
3. N. Senthil Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah, "Microprocessors and Interfacing", Oxford Higher Education, 1st Edition, 2012

References:

1. David A. Patterson and John L. Hennessy "Computer Organization and Design: The Hardware/Software Interface", Elsevier, 5th Edition, 2013
2. Ram, "Fundamentals of Microprocessors and Microcontrollers", Dhanpat Rai Publications, 2012
3. ARM Based Development course, NPTEL(https://nptel.ac.in/courses/117106111/)

Course Objectives: The main objective of this course is to introduce and provide insights regarding different organizations and architectures of computer. The objectives are further divided as:

1. To introduce organization and architecture of computer.
2. To provide a foundation to write an 8 bit microprocessor program using assembly language.
3. To infuse understanding of usefulness X-86 microprocessor family and other processors and fundamental principles of ARM processors.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Describe** basic concepts of the organization and architecture of computer and interfacing with external devices.	2	Understanding
CO2	**Illustrate** the knowledge gained about the data representation, internal organization, addressing modes, instruction set of 8085, 8086 and ARM processor for assembling language programming.	3	Applying
CO3	**Analyze** the working of processors like 8085,8086,ARM and interfacing of external devices like memory and I/O.	4	Analyzing

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	-
CO2	2	2	2	-	-	-	-	-	-	-	-	-	3	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	3	-

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

(Ms. A.S. Pawar)

(Mr. S.L. Mahadeshwar)

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to Computer Organization	**6Hrs.**
Introduction to Computer Organization and architecture, A brief history of computers, Von Neumann Architecture, designing for performance, Multicore, MICs and GPGPUs, Two Laws that Provide Insight: Amdahl's Law and Little's, Basic Measures of Computer Performance: Clock Speed, Instruction Execution Rate. Top level view of computer function and evolution: Computer Components, Computer Function, Interconnection Structures, Bus Interconnection, Point-to-Point Interconnect, PCI Express.	
Module 2: Data Representation and Computer Arithmetic	**6Hrs.**
The Arithmetic and Logic Unit, Integer Representation, Integer Arithmetic, Floating-Point Representation, Floating-Point Arithmetic, Programmable Logic Devices.	
Module 3: 8085 Microprocessor	**8Hrs.**
CPU organization, Microprocessors, Machine language, Assembly Language, Computer classification, Microprocessor Architecture, microcomputer systems; Single chip microcomputer: Microcontrollers, The 8085 microprocessor, machine cycles, 8085 Programming model, Instruction classification, Instruction Data format and storage, 8085 Instructions: Data transfer operations, Arithmetic operations, Logic operations, Branch operations.	
Module 4: X-86 microprocessor Family	**7Hrs.**
Microprocessor Architecture -8086, Register organization of 8086, Signal descriptions of 8086 chip, Physical Memory organization, Introduction to Maximum and Minimum mode operation, Addressing Modes, Co-processor configuration, interfacing of Co-processor with 8086.	
Module 5: Interfacing of Memory & Input / Output Devices	**7Hrs.**
Memory mapped I/o and I/O mapped I/O. Address decoding, interfacing of memory chips with 8085. Interfacing of interrupt controller with 8085, Programmable Interrupt Controller (8259A). Direct Memory Access (DMA), Stacks and subroutines.	
Module 6: Introduction to ARM Processor	**6Hrs.**
Arm core dataflow model, Registers, Current program status register, Pipeline, Exception, interrupt and vector table, Core extensions, Arm processor families, Data processing instruction and Arithmetic instruction.	

Module wise Measurable Students Learning Outcomes :
After the completion of the course the student should be able to:

Module 1:
- Describe different computer components.
- Illustrate Basic Measures of Computer Performance and its use.

Module 2:
- Illustrate computer arithmetic with examples.

Module 3:
- Describe the basics of microprocessors and analyze difference between the machine language and assembly language of a computer.
- Describe the peculiarities of the instructions as to their category, word size, machine cycles for execution, addressing mode etc.

Module 4:
- Illustrate the basics of X-86 family microprocessors and describe the functions of each of its components.

Module 5:
- Describe the interfacing between microprocessor and various peripherals.

Module 6:
- Illustrate ARM processor family using assembly instructions and their formats and usage.

(Mr. S.L. Mahadeshwar) (Ms. A.S. Pawar)

Title of the Course: Data Structures Laboratory **Course Code:** 4CS251	L	T	P	Cr
	0	0	2	1

Desirable requirements: Programming in C including pointers and File Handling

Textbooks:

1. Richard F. Gilberg, Behrouz A. Forouzan, "Data Structures, A Pseudocode Approach With C", Cengage Learning, Second Edition, 2014
2. S. Lipschutz, "Data Structures", Schaum's Outlines Series, Tata McGraw-Hill, 2013
3. Ellis Horowitz, S. Sahni, D. Mehta, "Fundamentals of Data Structures in C++", Galgotia Book Source, New Delhi, 2008

References:

1. Yashavant Kanetkar, "Understanding pointers in C", BPB Publication, 2009
2. N. B. Venkateshwarlu, E. V. Prasad, "C and Data Structures", S. Chand and Company, 2010

Course Objectives: This laboratory course focuses on practicing various linear and nonlinear data structures introduced in the theory course 4CS203. The assignment list mainly emphases on explaining characteristics of various data structures and their applications.

1. To develop and improve skills in programming in a systematic way and preparing the students for advanced computer science courses.
2. To make the students understand the concept of ADT, recursion, various searching and sorting algorithms along with their performance comparisons and to use appropriate data structure for modelling given problem.
3. To inculcate theoretical and practical knowledge of various linear and nonlinear data structures to solve real world problems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Demonstrate** the concept of recursion, abstract properties of various linear and nonlinear data structures, searching and sorting methods through implementation.	3	Applying
CO2	**Identify** suitable data structure to be used to solve the various problems.	4	Analyzing
CO3	**Select** appropriate searching, sorting method on the basis of its performance while developing application.	5	Evaluating

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	-	-	-	-	2	-	-	-	-	-	-	-		-
CO2	-	-	-	3	2	-	-	-	-	-	-	-	3	-
CO3	-	-	-	3	2	-	-	-	-	-	-	-	3	-

1: Low, 2: Medium, 3: High

Dr. M. L. Gavankar

Assessments :

Teacher Assessment:

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weights each.

Assessment	Marks
ISE	50
ESE	50

ISE is based on Experimental work/ Performance in laboratory/assignment
ESE: Assessment is based on Performance and oral.

Course Contents:

List of Experiments:

Assignments based on topics covered in course 4CS203

1. Program based on structures and pointers in C
2. Program based on arrays and pointers in C
3. File handling and command line arguments
4. Implementation of recursion
5. Developing ADT for singly linked list and its applications
6. Developing ADT for Doubly linked list and its applications
7. Developing ADT for circular linked list and its applications
8. Developing ADT for stack and queue and their applications
9. Implementation of double ended queue
10. Implementation of recursive and non-recursive tree traversals
11. Binary search tree and application
12. Implementation of graph, DFS, BFS
13. Implementation of searching : linear search, binary search, Fibonacci search
14. Sorting Methods: Insertion sort, shell sort, heap sort, quick sort, merge sort, radix sort etc.
15. Implementation of hashing

Dr. N. L. Gavankar

Title of the Course: Computer Organization And Architecture Laboratory **Course Code**: 4CS252	L	T	P	Cr
	0	0	2	1

Desirable requirements: Programming by using assembly language

Textbooks:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson Education, 8th Edition/10th Edition, 2010/2016
2. Ramesh S. Gaonkar, "Microprocessor architecture, programming & applications", Penram International publications (India) Pvt. Ltd, 6th edition, 2013
3. N. Senthil Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah, "Microprocessors and Interfacing", Oxford Higher Education, 1st Edition, 2012

References:

1. David A. Patterson and John L. Hennessy "Computer Organization and Design: The Hardware/Software Interface", Elsevier, 5th Edition, 2013
2. Ram, "Fundamentals of Microprocessors and Microcontrollers", Dhanpat Rai Publications, 2012
3. ARM Based Development course, NPTEL(https://nptel.ac.in/courses/117106111/)

Course Objectives:

The main objective of this course is to demonstrate insights regarding working of different organizations, components and architectures of computer. The objectives are further divided as:

1. To infuse skills of drawing flowchart by using assembly language programming.
2. To demonstrate block transfer, arithmetical, logical operations and code conversion method by using assembly language programs.
3. To demonstrate the working of ARM processor.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Grasp** the fundamentals of assembly level programming using microprocessor trainer kit and interfacing with other I/O devices.	2	Understanding
CO2	**Demonstrate** programming proficiency using the various addressing modes and instructions set (Block transfer, arithmetical, logical operations and code conversion method) of 8085 and X-86 microprocessor.	3	Applying

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	2				3									
CO2			3	2	2									

1: Low, 2: Medium, 3: High

(Mrs. A.S. Pawar)

(Mr. S.L. Mahadeshwar)

Assessments :

Teacher Assessment:

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weights each.

Assessment	Marks
ISE	50
ESE	50
ISE is based on Experimental work/ Performance in laboratory/assignment/declared test/etc. ESE: Assessment is based on Performance and oral.	
ISE is based on Experimental work/ Performance in laboratory/assignment/declared test/etc.	

Course Contents:

Assignments based on topics covered in course 4CS252

Write assembly language programs

1. Introduction to digital fundamental circuit design.
2. Study of the design combinational and sequential circuit.
3. Introduction of Microprocessors and Study of 8085 Microprocessor and instruction set.
4. Write a program to perform 8-bit block transfer.
5. Write a program to perform 8-bit and 16-bit addition /subtraction/multiplication/division.
6. Write a program to find largest /smallest number in an array of data.
7. Write a program to find smallest no in an array of data.
8. Write a program to find 16 bit 2's complement no of 4340H
9. Write a program to transfer 16 bytes of data stored in location at C250 to C25F to new memory locations starting from C300 on words.
10. Write a program to transfer a block of data. The data is stored in memory from C550 H to C555F H. The data is to be stored from C570 H to C57F H in reverse order.
11. Write a program to arrange 10 bytes data in ascending /descending order. The data is stored in memory as an array starting from C100 H onwards.
12. Write Convert a binary number to a BCD number.
13. Write a program to square of number using lookup table.
14. Write X86/64 ALP to perform basic arithmetic operation.
15. Write X86/64 ALP to count number of positive and negative numbers from the array.
16. 16. Write X86/64 ALP to perform multiplication of two 8-bit hexadecimal numbers. Use successive addition and add and shift method (Use of 64-bit registers is expected).
17. Write X86/64 ALP to convert 4-digit Hex number into its equivalent BCD number and 5-digit BCD number into its equivalent HEX number.
18. Case study: ARM Processor.

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

(Mr. S. L. Mahadeshwar)

(Ms A. S. Pawar)

Title of the Course: Programming Laboratory 1 Course Code: 4CS253	L	T	P	Cr
	0	0	4	2

Desirable Requirements: Introduction to any Programming Language

Textbooks:

1. Herbert Schildt, "The Complete Reference: C++ " Tata McGraw-Hill, 4th Edition, 2010
2. E Balaguruswamy, "Object Oriented Programming with C++ ", Tata McGraw-Hill, 4th Edition, 2008
3. Kenneth Lambert, "Fundamentals of Python: First Programs " Course Technology, Cengage Learning.2nd edition, 2017

References:

1. Stanley B. Lippman , "C++ Primer" Pearson , 4th Edition, Jan 2010

Course Objectives :

The course covers fundamentals of object oriented concepts using C++ & Python programming with syntax and examples. Course objectives of this course are as follows:

1. To provide in-depth coverage of object-oriented programming principles and techniques using C++ and Python.
2. To inculcate the advanced programming concepts in C++ and Python.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** the features of object oriented programming using C++ and Python.	2	Understanding
CO2	**Demonstrate** the solution to real world problems using C++ and Python	3	Applying

CO-PO Mapping : (Use 1,2,3 as correlation strengths)

PO and PSO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	-	-	-	2	-	-	-	-	-	-	-	2	-

1:Low, 2:Medium, 3:High

Assessments :

Teacher Assessment:

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weights each.

Assessment	Marks
ISE	50
ESE	50

ISE 1 and ISE 2 are based on Quiz and demonstration of programs.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Ms A.V. Tekchedkar

Dr B.B. Meshram

Course Contents:	
Module 1: Introduction to object oriented programming	**8 Hrs.**
Introduction to properties of object oriented programming, Beginning with c++ programs, operators, control structures, loops, examples with class and objects, Functions in c++, function overloading, Constructors, Destructors, operator overloading, static class members. **Experiments:** 1. Program based on creating Class and Object. 2. Program based on constructor and destructor.	
Module 2: Properties of object oriented programming	**9 Hrs.**
Inheritance and its types, pointers, virtual functions, Polymorphism, container class. File and Streams: Streams, String I/O, Character I/O, Object I/O, Exception Handling, Templates, Namespace fundamentals, Overview of Stream classes. **Experiments:** 1. Implementation of Inheritance and polymorphism. 2. Working with files and stream classes. 3. Use of template, generic template and function. 4. Creation of namespaces.	
Module 3: Introduction and getting started with python programming	**9 Hrs.**
Running Code in the Interactive Shell, Input, Processing, and Output, Editing, Saving, and Running a Script, Behind the Scenes: How Python Works. Data Types and expressions: Numeric Data Types and Character Sets, Integer, Floating-Point Numbers, Character Sets, Arithmetic Expressions, Functions and Modules. **Experiments:** 1. Introduction and getting started with python programming: running code in the interactive shell 2. Program based on expression, data type, functions	
Module 4: Features of python programming	**9 Hrs.**
Loops and selection statements, String and Text files, Lists and dictionaries: List Literals and Basic Operators, List Methods for Inserting and Removing Elements, Dictionary Literals. **Experiments:** Programs based on implementation of loops, strings, lists and dictionaries.	
Module 5: Design with Classes	**8 Hrs.**
Getting Inside Objects and Classes, A First Example: The Student Class, Graphical User Interfaces, Coding Simple GUI-Based Programs, Windows GUI components. **Experiments:** Programs based on Graphical user interface design using python.	
Module 6: Network Programming, file handling and data structure using python	**9 Hrs.**
Multi-threading, Networks, and Client/Server Programming, Searching, Sorting, Exception handling, string processing, file handling, stack, Queues, heaps. **Experiments:** 1. Programs related to Multi-threading, file handling. 2. Programs related to concepts like stack, Queues, heaps.	

Dr. B.F. Momin

Ms. A.V. Teelchedkar

Title of the Course: Development of Societies Course Code: 4HS201	L	T	P	Cr
	2	**0**	**0**	**2**

Pre-Requisite Courses: Nil

Textbooks:

1. Bakshi. P. M, "The Constitution of India" Universal Law Publishing Co., Delhi, 2009
2. Sankhdher, M.M. "The Welfare State", Deep and Deep publications, Delhi, 2003
3. Ved Prakash. K. Biswal, "Perspectives on Education and Development", Shipra Publication, 2008

References:

1. James Midgley, "Social Development: Theory and Practice", Sage publication, 2005
2. David Piachaud and James Midgley, "Social Protection, Economic growth and Social change", Edward Elgar publications, 2013
3. Szymon Chodak, "Societal Development: Five Approaches with Conclusions from Comparative Analysis", Oxford University Press, 1974

Course Objectives :

1. Introduce students to the field of social development with a strong emphasis on families and communities using the Development Goals and Human Rights frameworks.
2. Provide students with an understanding of the key concepts and issues related to societal development such as poverty, inequality, and exclusion.
3. Encourage students to explore alternative paths of societal development that promotes the well-being of individuals, families, and communities in India or around the world.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	Explain "Societal development" and the role of India's Development Goals in shaping social development in the globalized world.	2	Understanding
CO2	Examine critically the role of human rights in constraining or advancing development of societies.	2	Understanding
CO3	Describe the key social development issues confronting individuals, families, and communities in contemporary societies and explore the role of social advertisement and education in promoting Societal development in India.	2	Understanding

CO-PO Mapping :

PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1						2	2							
CO2						2	2							
CO3						2	2							

(M.S. Ali)

01/06/17
Dr. B.F. Momin

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: CONCEPT AND DEFINITIONS OF DEVELOPMENT.	**Hrs.**
Meaning and Concept of development, development in India in Pre British, British and Post British period, Idea of development in current context, Characteristics of Development, Perspectives on Development, Dimensions of Development, Models of Development.	4
Module 2: SOCIAL DEVELOPMENT	**Hrs.**
Social development: Meaning and definitions, Relationship between human being and society, Concept behind the origin of Family, Clan and Society, Children's rights, education and social development, Women's rights, gender equality and social development, Features of Social Development, Social Development in the United Nation's Agenda, Social Development in India, Factors facilitating Social Development, Factors hindering Social Development, Comparative study on different models of social structures and their evolution.	5
Module 3: ECONOMIC DEVELOPMENT	**Hrs.**
Meaning and concept, Capitalism, Socialism, Marxism. Barter, Jajmani. Materials economy: The story of stuff project. Characteristics of economic development, Why countries desire economic development? Key drivers of economic development, Circle of Economic Development, Phases of economic development, Barriers to economic development, Buddhist Economics, Gandhian idea of Development, Swarajya and decentralization.	7
Module 4: POLITICAL DEVELOPMENT	**Hrs.**
Concept, History and ideas of political system Different models of governing systems and their comparative study.	3
Module 5: HUMAN DEVELOPMENT	**Hrs.**
The Concept of Human Development, Human Development in the United Nation's Agenda, Human development Approach vs. the Conventional Development Approach, Indicators of human development, Economic development and human development, Barriers to human development:	5
Module 6: SUSTAINABLE DEVELOPMENT	**Hrs.**

(N.S. Ali)

Meaning and definition, Origin of the concept, World Conventions on Sustainable Development, Objectives of sustainable Development, Requirements of sustainable Development, Dimensions of Sustainable Development, Key Issues in Sustainable Development, Challenges to Sustainable Development	6
Module wise Outcomes At end of each module students will be able to **Module 1:** • Conceptualize what is development, its characteristics, its dimensions, perspectives and models. **Module 2:** • Comprehend the meaning and features of social development and the UN's commitment for social development. Added to that you can note the process of social development in India along with the factors facilitating and hindering social development. **Module 3:** • Understand the meaning of economic development and growth along with its characteristics, need of economic growth, phases of economic growth, driving forces that promote economic growth, its difference from economic development and barriers to the process. **Module 4:** • Understand the meaning of political development, ideas of political system and different models of governing systems. **Module 5:** • Develop an idea of the concept of human development, the reflection of the concept of human development in the UN agenda, how the concept departs from the conventional development models, indicators of human development and barriers to human development. **Module 6:** • Trace out the meaning, origin, requirements of sustainable development, its pre-requisites. The unit will also impress upon the students about the world conventions on sustainable development, its dimensions, issues arising and challenges faced by the process.	

(M.S. Ali)

Title of the Course: Software Engineering	L	T	P	Cr
Course Code: 4CS221	3	0	0	3

Desired requirements:

Textbooks:

1. Pankaj Jalote, "An Integrated Approach to Software Engineering", Narosa Publishers, 3rd Edition, 2005.
2. Ian Sommerville, "Software Engineering", Addison-Wesley, 7th Edition, 2004.
3. James Rumbaugh, "Object Oriented Modeling and Design with UML", Pearson, 2nd Edition,2004.

References:

1. Roger S. Pressman, "Software Engineering: Practitioner's Approach", McGraw Hill, 7th Edition, 2010.
2. Jawadekar W.S., "Software Engineering: principles and practices", Tata McGraw Hills, 1st Edition.
3. Gillies A.C. and Smith p., "Managing Software Engineering: CASE studies and solutions", Chapman and Hall, London.

Course Objectives :

1. To unleash the orientation & importance of engineering approach to software development.
2. To infuse the knowledge of software processes & models practiced at IT industries.
3. To acquaint students with the SDLC phases in detail.
4. To emphasize on Design aspect with UML technology.
5. To inculcate the importance of software quality by virtue of software testing methods.

Course Learning Outcomes:

CO	After the completion of the course the student Learner be able to	Bloom's Cognitive	
		level	Descriptor
CO1	Grasp industry processes on software development to become IT industry-savvy.	2	Understanding
CO2	Prepare with the spirit of team-working and importance of using artifacts at SDLC phases.	3	Applying
CO3	Distinguish and evaluate procedural & OO based development practices.	4	Analyzing
CO4	Integrate expertise on CASE tools usage especially for design and testing of software to undertake industrial strength software projects.	6	Creating

A.R. Garve

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1			3								3	2	3	
CO2			1	2				3	3	3				
CO3					2									
CO4			2									2		3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on pedagogy such as brainstorming, role play, quiz, presentations etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Software Processes	**6 Hrs.**
Need of software engineering approach, ETVX model, project management process, software development process & models, configuration management process, process management process.	
Module 2: Software Quality & Project Planning	**6 Hrs.**
Quality objectives, software quality factors, PAF Model, quality standards, project management plan, cost estimation, project scheduling, personnel planning with WBS, risk management.	
Module 3: Software Requirement Analysis & Function Oriented Design	**7 Hrs.**
Software requirement process, need and characteristics of SRS artifact, design principles, module level concepts, design notation and specifications, structured	

A.R. Surve

design methodology.	
Module 4: Object Oriented Design with UML & Continual Integration	**8 Hrs.**
UML model, UML diagrams: Use-case, Class, Activity, State-chart, Interaction, Sequence, Collaboration, Component, Deployment. Continual integration with Agile model process frameworks.	
Module 5: User Interface Design & Coding	**4 Hrs.**
UI rules, UI analysis and steps in UI design, best programming practices such as TDD & pair programming, verification.	
Module 6: Software Testing	**8 Hrs.**
Testing purpose and concepts, test process, levels of testing, regression testing, test case design for functional testing & structural testing. Study of Open-source Tools.	

Module wise Measurable Students Learning Outcomes :

The student should be able to:

Module 1: Software Processes

- Awareness of Software processes & Models used at IT.

Module 2: Software Quality & Project Planning

- Grasp quality parameters and standards such as PAF.
- Know & prepare project planning phases and responsibilities with WBS.

Module 3: Software Requirement Analysis & Function Oriented Design

- As per SDLC phase understand requirement process and need of SRS artifact. Understand functional & non-functional requirements as well. Realize the importance of design aspects, concepts & methodology. Practices to learn how to draw DFD on requirements.

Module 4:Object Oriented Design with UML & Continual Integration

- Building capability to draw & distinguish various UML diagrams on requirements. Articulating usage of Continual integration with Agile model process frameworks.

Module 5: User Interface Design & Coding

- Know the UI aspect of interactive design for enterprise applications.
- Learn best coding standards/practices such as TDD, pair programming and how to verify code.

Module 6: Software Testing

- Integrate expertise on how testing helps in quality of software. Know testing concepts, levels of testing. Learn and practice Black & white box testing along with test case generations using open-source tools.

A. R. Surve

Title of the Course: Formal Language and Automata Theory Course code: 4CS222	L	T	P	Cr
	3	1	0	4

Desirable requirements: Discrete Mathematics

Textbooks:

1. John C. Martin, "Introduction to Languages & Theory of Computation", Tata McGraw-Hill , 3rd Ed., 2009
2. John E.Hopcraft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computations", Pearson Edu., 3rd Ed., 2009
3. Daniel I. A. Cohen, "Introduction to Computer Theory", Wiley, 2nd Ed., 2008

References:

1. J.P.Tremblay & R.Manohar, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw-Hill, 2008
2. K.L.P. Mishra & N. Chandrasekaran, "Theory of Computer Science", PHI, 2nd Ed., 2002
3. Vivek Kulkarni, "Theory of Computation", Oxford University Press, 1st Ed., 2013

Course Objectives :

This course is one of the core subjects for Computer Science and Engineering students which deals with the theory related to the practical aspects of computation. The main emphasis is on solving problems universally encountered in designing a language translator, regardless of source or target machine.

1. To explain basic terminologies related to formal languages and Automata theory.
2. To provide foundation to critically analyze grammars, regular expressions, languages, and their relationship.
3. To inculcate theoretical knowledge to design Automata/Machine as a language descriptor and recognizer.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** the fundamental concepts related to string, language, grammar and their properties	2	Understanding
CO2	**Examine** and **Construct** different grammars, regular expressions and relate the languages defined by different grammars and regular expressions.	3	Applying
CO3	**Design** Finite Automata, PDA, Turing Machine to recognize different languages.	6	Creating

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-	3	-
CO3	3	3	-	2	-	-	-	-	-	-	-	-	3	-

1: Low, 2: Medium, 3: High

Dr. N. L. Gavankar

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**6 Hrs.**
Types of Proofs, Mathematical Induction and Recursive definitions, Regular expressions & corresponding regular languages, examples and its applications, unions, intersection & complements of RL, Pumping Lemma for RL.	
Module 2	**10 Hrs.**
Deterministic finite automata definition and representation, Nondeterministic F.A., NFA with ^ transitions, Equivalence of DFAs, NFAs and NFA-^s. Kleene's theorem & proofs, minimum state FA for a regular language, minimizing number of states in an FA.	
Module 3	**6 Hrs.**
Definition and types of grammars and languages, derivation trees and ambiguity, CFL's & Non CFL's., Union, Concatenation and Kleene's operations, Intersection and complements of CFLs, Pumping Lemma & examples.	
Module 4	**6 Hrs.**
Definition, deterministic PDA, types of acceptance and conversions to each other, CFGs & PDAs, Top-Down, & Bottom-up parsing.	
Module 5	**4 Hrs.**
BNF, CNF and GNF notations, Eliminating ^ production and unit productions from a CFG, Eliminating useless variables from a Context Free Grammar.	
Module 6	**7 Hrs.**
Models of computation, definition of TM as Language Acceptors, Combining Turing Machines, computing a function with a TM. Variations in TM, TMs with doubly-infinite tapes, more than one tape, Nondeterministic TM and Universal TM.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1:

- Explain basic terminologies related to theory of computation and construct regular expressions recognising regular languages.

Module 2:

- Explain finite state system and design finite automata for regular languages.

Module 3:

- Explain language syntax, grammar construct context free grammars for languages.

Module 4:

- Design push down automata and demonstrate different parsing techniques.

Dr. N.L. Gavankar

Module 5: • Explain different normal forms and their applications. **Module 6:** • Design Turing machines for different formal languages and illustrate variants of Turing machine.
Tutorial: Based on the syllabus, 15 assignments will be given to the students focusing on problem solving approach.

Dr. N.L. Gavankar.

Title of the Course: Operating Systems **Course Code:** 4CS223	L	T	P	Cr
	3	0	0	3

Desirable requirements:

Textbooks:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating System Concepts", John Wiley, 10th Edition, 2018
2. D. M. Dhamdhere,"Operating Systems A Concept-Based Approach", McGraw-Hill, 3rd edition, 2012

References:

1. Charles Crowley, "Operating System A Design Oriented Approach", McGraw-Hill Education Pvt. Ltd., 2001
2. Achyut S. Godbole, Atul Kahate "Operating System with Case Studies in Unix, Netware and Windows NT", Tata McGraw Hill,3rd edition, 2010
3. D.M.Dhamdhere, "System Programming and Operating Systems", Tata McGraw - Hill, 2nd Edition, 1999

Course Objectives: A successful student will be able to understand the basic components of a computer operating system, and the interactions among the various components. The course will cover an introduction on the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

1. To introduce students with basic concepts of operating system, system software, threads and their communication
2. To familiarize the students with various views and management policies adopted by O.S. as pertaining with processes , Deadlock , memory , File and I/O operations.
3. To provide the knowledge of basic concepts towards process synchronization, Mutual exclusion algorithms and deadlock detection algorithms and related issues.
4. To inculcate importance of memory management, storage management and I/O device management in OS design.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Describe** the primitive concepts of Operating System services and system software functionality.	2	understanding
CO2	**Illustrate** Process management, Memory management, Storage management and I/O management core techniques in effective execution of processes.	3	applying
CO3	**Assess** various algorithms of Process, Memory, Storage & I/O management for performance and quality criterion.	5	evaluating

CO-PO Mapping :

PO and PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO12	PSO1	PSO2
CO1	2													
CO2	3	2											2	
CO3	2	3											3	

1: Low, 2: Medium, 3: High

(Mr. S. L. Mahadeshwar)

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 : Overview of Operating System	**6Hrs.**
Notion of operating systems ,Operating system services, user operating system interface, system calls, types of windows and UNIX system calls, system programs, operating system design and implementation, operating system structure, Virtual Machines **Case Study** : Windows and UNIX Operating System	
Module 2 : System Softwares	**6Hrs.**
Notions of editors, Macro processors, Compilers, Assemblers, loaders & linkers, Multiprogramming and time sharing.	
Module 3 : Process Management	**7Hrs.**
Process Concept : Process concept, process scheduling, operation on process, inter-process communication, example of IPC systems and communication in client-server systems. **Process Scheduling:** Basic concepts, scheduling criteria, scheduling algorithm, algorithm evaluation.	
Module 4 : Process Coordination	**7Hrs.**
Synchronization : Background, the critical section problem, Peterson's solution, synchronization hardware, semaphores, classic problems of Synchronization. **Deadlock :** System model, deadlock characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection.	
Module 5 : Memory Management	**8Hrs.**
Memory-Management Strategies : Background, swapping, contiguous memory allocation, paging, structure of the page table, Segmentation. **Virtual Memory Management :** Background, demand paging, copy-on-write, page replacement algorithms, allocation of frames, Thrashing.	
Module 6 : Storage Management	**5Hrs.**
File System : File concept, access methods, directory and disk structure, file-system mounting, file sharing, protection.	

(Mr. S. L. Mahadeshwar)

Module wise Measurable Students Learning Outcomes :

Module 1:

- Describe the basic functions of OS, its components and its working.

Module 2:

- Illustrate the basic terminologies of system softwares like compiler, assembler.

Module 3:

- Describe the issues related to process management and solve the CPU scheduling problems.

Module 4:

- Describe different ways of process synchronization and handling deadlocks.

Module 5:

- Explain the issues related to memory management.

Module 6:

- Describe different ways of how logical view of File system is provided to the users by OS.

(Mr. S.L. Mahadeshwar)

Title of the Course: Database Engineering Course Code: 4CS224	L	T	P	Cr
	3	0	0	3

Desirable requirements: Data Structures

Textbooks:

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", Mc-Graw Hill New York Publications, 6th Edition, 2011

References:

1. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", Mc-Graw Hill New York Publications, 3rd Edition, 2003
2. Ramez Elmasri and Shamkant Navathe, Benjamin Cummings, "Fundamentals of Database Systems", 3rd Edition, 1999 / later
3. Bipin c. Desai "An Introduction to Database System", Galgotia Publications, 2nd revised edition

Course Objectives : Goal of this course is to elucidate basics of database design, provide bird view of data using ER- model, introduce relation model to depict relation between them, discussion of clause to manipulate, access data using Query language, apply normalization to remove redundancy, explain access control mechanism for security and introduce storage and indexing strategies. Course objectives are as follows,

1. To Impart various functional components of database design, manipulation and access language, redundancy issue, storage strategy, transaction and concurrency strategy and its security and recovery system
2. To Introduce an physical and logical database designs, database modeling, relational, hierarchical and network models
3. To Provide in depth understanding of relational model and the theoretical issues associated with relational database design.
4. To Exemplify various SQL clauses of Data manipulation, Data access and Data control.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Explain** concepts of conceptual database design, redundancy problem, storage system, transaction processing, concurrency control and security in DBMS	2	Understanding
CO2	**Apply** theoretical knowledge to design ER diagram, prepare relational schema using appropriate constraints and normalization for a given specification of the requirement	3	Applying
CO3	**Construct** SQL queries for Open source and Commercial DBMS for a given specification schema to fetch essential data	3	Applying

CO-PO Mapping :

PO and PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	-	-	-	-	-	-	-	-	-	2	-
CO3	-	-	2	-	-	-	-	-	-	-	-	-	-	-

1: Low, 2: Medium, 3: High

KPK

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction and Database Modelling using ER Model	**6 Hrs.**
Introduction: General introduction to database systems, its advantages and applications, Database System Architecture, Database users and Administrator, Data models, Database management system, Database languages, View of Database, Data Models. **ER Model:** Entity set, Entity types, attributes, Notations, Relationship sets, Relationship types, Keys- super key, candidate key, primary key, Extended Features of ER Model-Generalization, Specialization and aggregation	
Module 2: Relational Model and SQL	**8 Hrs.**
Relational Model: Structure of Relational Database, Reduction of ER model into Relational schemas, Schema-instance distinction, Referential integrity and foreign keys, Relational algebra, Tuple relation calculus, Domain relational calculus, Example queries, **SQL**: Introduction to SQL, Data definition statements with constraints, Insert, Update and Delete, Set Operations, Aggregate functions group by and having clauses, Nested Queries, Views, Complex Queries, Joins.	
Module 3: Relational Database Design	**7 Hrs.**
Importance of a good schema design, Motivation for normal forms, Atomic domains and 1NF, Dependency theory - functional dependencies, Closure of a set of FD's, Definitions of 2NF, 3NF and BCNF, Decomposition algorithms and desirable properties of them, Multi-valued dependencies and 4NF, Join dependencies and definition of 5NF, Temporal Functional Dependencies	
Module 4: Data Storage and Indexing	**6 Hrs.**
File organization, Organization of records in files, Data Dictionary, Database Buffer, and Indexing: Concept, Ordered Indices-Primary, Secondary, Multilevel, B+ Tree Index, Hashing, Hash Indices, Dynamic hashing, Multiple key access, Bitmap Indices.	
Module 5: Transaction Processing and Concurrency Control	**7 Hrs.**
Transaction Processing: Concept, ACID properties, Transaction states, Storage Structure, Implementation of atomicity, isolation and durability, Serializability, Testing for serializability. **Concurrency Control**: Lock-based protocols, Timestamp - based Protocols, Validation - based Protocols, Multiple Granularities, Deadlock handling.	
Module 6: Database security and Recovery System	**5 Hrs.**
Authentication, Authorization and access control, Discretionary Access Control (DAC), Mandatory Access Control (MAC) and Role of the Database Administrator (RBAC) models, Intrusion detection, SQL injection. Failure classification, Recovery and Atomicity, Log based recovery, Checkpoints, Shadow Paging, Buffer management in crash recovery.	

KPK

Module wise Outcomes

At end of each module students will be able to

Module 1

- Explain the concept of database system and its applications, database system architecture and various database models, appropriate constraints, describes entity, attribute, relation, key, primary key, super key, candidate key, extended features specialization and generalization with notations.

Module 2

- Construction of ER- model, relation model to represent complex data in pictorial form for better design and extract information from the database by constructing SQL queries.

Module 3

- Illustrate and use the concept of functional dependency and various normal forms for "good" database design.

Module 4

- Describe file organization concepts and various indexing techniques.

Module 5

- Describe the concept of transaction and implement transactions and compare various concurrency control mechanisms and apply the concepts for hands-on experimentation.

Module 6

- Identify and define Authentication, Authorization and access control mechanisms for data security and recovery mechanisms using log based recovery, checkpoints, shadow paging, and Buffer management in crash recovery.

Title of the Course: Computer Network **Course Code:** 4CS225	L	T	P	Cr
	3	0	0	3

Desirable Requirements : Data Communication

Textbooks:

1. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw-Hill, 4th/5th edition, 2017
2. William Stallings, "Data and Computer Communications", Prentice Hall (PHI) , 8th/9th edition, 2010/2011
3. Andrew S. Tanenbaum, "Computer Networks", Prentice Hall (PHI), 3rd /5th Edition, 2008/2010

References:

1. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Pearson Education,5th /6th edition, 2012/2013
2. Thomas G. Robertazzi , "Computer Networks and Systems: Queueing Theory and Performance Evaluation", Springer, 2nd edition, 2000

Course Objectives: The course is designed to give a clear view of computer networking by introducing them to networking protocols, features and techniques. Objectives are divided as below:

1. To recall protocol functions and issues related to Data Link layer.
2. To explain the features and operations of various protocols in TCP/IP suite.
3. To elaborate the design and configuration of various networking protocols.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Articulate** networking basics and different layers in networking models	2	Understanding
CO2	**Examine** the features and operations of protocols of data Link Layer, Network layer, transport layer and Application Layer.	3	Applying
CO3	**Categorize** and **compare** networking protocols.	4	Analyzing

CO-PO Mapping :

PO and PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	1	-	-	-	-	-	-	-	-	-	-	-

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

4/6/19

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Networking Basics	**4 Hrs.**
Evolution of network, Introduction to Computer Networks, Types of Network, Physical & Logical Topology, Introduction to different types of network, internetworking, Intranet, Internet and revisit to Reference models-OSI, TCP/IP.	
Module 2:Data Link Layer	**8 Hrs.**
The Channel Allocation Problem-Static and Dynamic Allocation, Multiple Access Protocols-ALOHA, CSMA, CSMA/CD, WDMA, WLAN. Ethernet-cabling, coding, MAC Protocol, Binary exponential back off algorithm, performance, switched Ethernet, fast Ethernet, gigabit Ethernet. Wireless LANs-802.11 stack, physical layer, MAC, frame structure Bluetooth-architecture, application, protocol stack, Data Link Layer Switching- Bridge, hub, repeater, switch, router, gateways, VLAN.	
Module 3: The Network Layer:	**7 Hrs.**
Logical Addressing: IPv4 addresses , IPv6 addresses, internetworking, IPv4, IPv6, transition from IPv4 to IPv6, Address Mapping, ICMP, IGMP, Unicast and Multicast Routing, Numerical problems on logical addressing.	
Module 4: The Transport Layer:	**7 Hrs.**
Process-to-process delivery, user datagram protocol (UDP), TCP, SCTP, Socket Programming,	
Module 5: Congestion Control and Quality of Service	**6 Hrs.**
Congestion, congestion control, congestion control in TCP, introduction to queuing theory, quality of service, techniques to improve qos, integrated services, differentiated services.	
Module 6: Application Layer	**7 Hrs.**
Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP.	

Module wise Measurable Students Learning Outcomes :
After the completion of the course the student should be able to:

Module1 :
- Articulate the networking Basics.

Module2 :
- Explain and examine wired and wireless communication with medium access control layer.

Module3 :
- Understand the working of network layer and compare the techniques for routing at network layer.

Module4 :
- Examine the services provided by transport layer.

Module5 :
- Compare techniques to improve QoS. and congestion control

Module6 :
- Articulate knowledge of various application layer protocols.

Title of the Course: Database Engineering Laboratory **Course Code:** 4CS271	L	T	P	Cr
	0	0	2	1

Desirable requirements: Data Structures

Textbooks:

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", Mc-Graw Hill New York Publications, 6th Edition, 2011

References:

1. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", Mc-Graw Hill New York Publications, 3rd Edition, 2003
2. Ramez Elmasri and Shamkant Navathe, Benjamin Cummings, "Fundamentals of Database Systems", 3rd Edition, 1999 / later
3. Bipin c. Desai "An Introduction to Database System", Galgotia Publications, 2nd revised edition

Course Objectives : Main objective of this course is to practically demonstrate the ER- model for given specific requirement using open source or commercialized tool, show transformation of ER-model into Relation model on paper as well as on s/w tool, depict Relation model in table format on Open source or commercialized DBMS using query language and introduce advance topics to interact with DBMS like view, trigger, procedures and aspects of authorization.

1. To elaborate use of conceptual database designs to prepare database schemas, indexing, transaction processing, concurrency and recovery control issues associated with database management systems.
2. To make the students aware of various relational database systems and the systematic approach to apply theoretical knowledge to design practical applications to solve real world problems on the small scale.
3. To make the students understand SQL and to use it efficiently to retrieve data from the database.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Interpret** the problem statement of an enterprise, identify the need, analyse the problem and design ER diagram for the enterprise as well as prepare the relational database schema for the enterprise identifying integrity constraints for efficient design using modern tools.	3	Applying
CO2	**Apply** systematically theoretical knowledge to design practical applications to solve real world database problems on the small scale and theoretically justify the design and use fundamental transaction processing, concurrency control etc. in real applications.	3	Applying
CO3	**Compare** and use various ways of writing the queries for a given problem and extract required information from the database.	4	Analyzing

CO-PO Mapping :

PO and PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	2	2	2	-	-	-	-	-	-	-	3	-
CO2	-	-	-	2	3	-	-	-	-	-	-	-	3	-
CO3	-	-	-	3	-	-	-	-	2	-	-	-	3	-

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weightage each.

Assessment	Marks
ISE	50
ESE	50

ISE is based on performance of students in laboratory, experimental write-up, presentation, oral, and test (Surprise/ declared/ quiz). The course teacher shall use at least two assessment tools as mentioned above for ISE.
ESE: Assessment is based on performance and oral.

Course Contents:

Assignments to be carried out in any RDBMS like ORACLE//DB2/SQL-Server/PostgreSQL:
Assignments include conceptual design using ER model, SQL and PL/SQL

1. Database Design using ER model
2. Database schema design
3. Database creation and applying integrity constraints
4. Study of DDL statements and data manipulation statements
5. Study of Basic SQL SELECT statement for displaying data from single table or multiple tables
6. Study of SQL constructs for aggregating data using group functions, sub-queries and complex queries
7. Study and Implementation of Triggers
8. Study and Implementation of Stored Procedures
9. Transaction isolation levels and Concurrency control
10. Few aspects of authorization such as creating and managing users, roles, granting and revoking of privileges
11. Implementation of B+ tree, hash index in C or C++

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Title of the Course: Computer Network Laboratory **Course code:** 4CS272	L	T	P	Cr
	0	0	2	1

Desirable Requirements: Data Communication

Textbooks:

1. Richard Steven, "Unix network programming", for Socket Programming, Prentice Hall ,3rd edition, 2015
2. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Pearson Education,5th /6th edition, 2012/2013

References:

1. Jeffery S. Beasley, "Networking", New Riders Press, 2nd edition, 2008.
2. Larry L. Peterson, Bruce S. Davie "Computer Networks: A Systems Approach", The Morgan Kaufmann Series in Networking, 5th edition, 2011.

Course Objectives: The course is designed to give the practical view of various networking concepts and protocols using tools and simulators.

1. To dig up theoretical and practical knowledge in computer networks.
2. To distinguish and show how to design and analyze different types of communication protocols.
3. To interpret basic skills needed to write network application using socket interface.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Demonstrate** the practical aspect of networking related to the theoretical concepts.	3	Applying
CO2	Simulate, configure and **analyze** the network using networking tools.	4	Analyzing

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	1	-	-	2	-	-	-	-	-	-	-	-	1	-
CO2	-	-	-	-	3	-	-	-	-	-	-	-	-	-

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weights each.

Assessment	Marks
ISE	50
ESE	50
ISE is based on Experimental work/ Performance in laboratory/assignment/declared test/etc. ESE: Assessment is based on Performance and oral.	
ISE is based on Experimental work/ Performance in laboratory/assignment/declared test/etc.	

21/6/19 PDM.

Course Contents:

At least 10 to 12 assignments should be conducted on following topics:

1. Study of Internetworking devices.
2. Study of basic networking commands and network configuration.
3. Study of packet capturing and analyzing tools on windows platform(e.g. Wireshark)
4. Wireshark Lab: Ethernet and ARP.
5. Wireshark Lab: 802.11
6. Configuration of network topology using packet tracer tool
7. Configuration of routing protocols
8. Configuration of IPv6 address using Packet Tracer
9. Capture and analyze TCP and UDP packet using Wireshark
10. Analyzing TCP connection and termination using Wireshark
11. Socket programming using TCP and UDP.
12. Wireshark Lab: HTTP, DNS

Module wise Measurable Students Learning Outcomes :
After the completion of the course the student should be able to:

4/6/19 P.D.M.

Title of the Course and Course code: Programming Laboratory 2 **Course Code:** 4CS273	L	T	P	Cr
	0	0	4	2

Desirable Requirements: Object Oriented Paradigm, Object Oriented Concept and basic implementation in C++.

Textbooks:

1. Cay S. Horstmann, Gary Cornell "Core Java Fundamentals Volume –I" (The Sun Microsystems Press Java Series), 10th Edition, March 2016
2. Cay S. Horstmann, Gary Cornell, "Core Java Volume – II" (The Sun Microsystems Press Java Series), 10th Edition, April 2017

References:

1. Herbert Schildt, "Java Complete Reference", McGraw Hill Education, 10th Edition, November 2017
2. Kathy Sierra and Bert Bates, "Oracle Certified Associates JAVA Standard Edition 8 Programmer I Exam Guide", McGraw Hill Education (Oracle Press), May 2017
3. Kathy Sierra and Bert Bates, "Oracle Certified Associates JAVA Standard Edition 8 Programmer II Exam Guide", McGraw Hill Education (Oracle Press), July 2018

Course Objectives :

Summary: Java is widely used in every corner of world and of human life. Java is not only used in software's but is also widely used in designing hardware controlling software components. JAVA programming language provides variety of data types, methods and some of them are included in syllabus. Learning Java serves as a good introduction to software development. Main objectives are as follows-

1. To inculcate the understanding of JAVA programming environment, basic object oriented programming with JAVA (JAVA version 1.8 and above or the latest java version)
2. To introduce selection of appropriate concepts of java programming such as static and non-static classes and access modifiers, user defined classes, collection, interface, exception handling, multi-threading, packages like – i/o, util, net, jdbc etc.
3. To infuse skills of integrating all components to build small java application for real world problem.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Convert** the real world problem using simple java programing domain and identify the required java object oriented concept	2	Understanding
CO2	**Demonstrate** small application using java as a programing language for socio economic importance	3	Applying

(SMR)

5. Static block, initialization block and constructor block – execution order 6. Implementation of different types inheritance, Multiple Inheritance using Interface 7. Implementation of Inheritance • Method overriding • super constructor and super keyword • abstract class • not allow class or method or both to extend/inheriting to another class 8. Implementation of Package and access mechanism in package • Exception handling in package 9. String class implementation, basic operation, creating immutable and mutable string 10. Exception Handling for – Checked Exception • Divide by zero error • Null values • Data entry • Checked exception classes • Exception handling – checked exception, order of exception handling, throwing exception • Creating user defined exception	
Module 2 - JAVA IO AND UTIL PACKAGE	**14 Hrs.**
I/O programming – Hierarchy of classes in I/O Package Streams Classes: Character oriented and Byte oriented, reading and writing Reading and Writing basic data types from keyboard File handling in Java. Collection Classes: java.util package Utility Methods for Arrays – Array Class The Collection Framework : Collections Hierarchy, List, Set, Queue, Map Date & Times class – get time and date, set date and time **Experiments:** 1. Program to read basic data types from keyboard using Scanner and check the entered values' data type for its appropriateness. • Different classes of IO and reading values from keyboard • Exception in IO 2. Program to read the data from user and save it to two different files, display the contents and exchange the contents of those two files using IO package – byte by byte. 3. Program to read the data from user and save it to two different files, display the contents and exchange the contents of those two files using IO package – char by char. 4. Program to read the data from user and save it to two different files, display the contents and exchange the contents of those two files using IO package – Object by Object. 5. Implement Arrays Class and perform array operation. 6. Implement collection utility classes – list, set, queue, map with their specific methods available in interface or implemented class. 7. Implement exception related to IO and collection classes.	

(SMR)

CO-PO Mapping :

PO and PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	3	-	-	-	-	-	-	-	-	-
CO2	2	2	1	-	3	-	-	-	-	-	-	-	-	-

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weights each.

Assessment	Marks
ISE	50
ESE	50

ISE is based on experimental work/ performance in laboratory/assignment etc.
ESE: Assessment is based on performance and oral.

Course Contents:

Module 1 - FUNDAMENTALS OF JAVA — **14 Hrs.**

An Introduction to Java - Features of JAVA language, Java Programming Environment – JDK, JRE, JVM, Fundamental Programming Structures in Java, Comparison of Java with C++
Class and Object, use of keywords like final, static, abstract, interface, etc
Wrapper Classes, value conversion primitive to object and object to primitive, toString use
Inner Classes - Static and Non-Static inner classes
Inheritance, Interface, Polymorphism, Overriding
Packages and Access Control Mechanism
String Class – operation on string, string-pool, equals and == difference on string, immutable and mutable string class, StringBuilder/StringBuffer class
Exceptions Handling – Checked Exception and UncheckedException, User Defined Exception Creation and use
Debugging the JAVA code

Experiments:

1. Installation of jdk package, understand the difference between jdk and jre folder, set environment variable PATH/CLASSPATH.
2. Describe JDK, JRE and JVM. Differentiate between C, C++ and JAVA.
3. Simple hello word program for understanding – java structure, command and steps for executing java program. Also simple program for reading input from user using scanner class.
4. Class and Method Implementation by –
   - Method Overloading
   - Constructor Overloading
   - Static - data members and methods
   - Inner classes
   - Simple Exception handling – checked exception, order of exception handling, throwing exception
   - Debugging of java program

(SMR)

Module 3 - MULTITHREDING IN JAVA	**8 Hrs.**
Multithreading – Classes support thread creation and execution Thread States & Synchronization of threads Deadlock handling **Experiments:** 1. Multithreading – display thread information. 2. Multithreading – create thread using Thread and Runnable class. 3. Multithreading – thread communication and synchronization of threads. 4. Implement exception related to multithreading.	
Module 4 – JAVA-ORACLE DATABASE CONNECTIVITY	**6 Hrs.**
Introduction to JDBC (Oracle Connectivity) JDBC Drivers & Initialization Creating Connection and Connecting to Databases CURD operation Using JDBC (Oracle Connectivity) Performing operations on specific row in oracle database using JDBC **Experiments:** 1. Design Database program for Employee details and implement INSERT, SELECT, DELETE, and UPDATE queries. 2. Implement ResultSet class. 3. Implement RowSet class. 4. Implement exception related to java database connectivity.	
Module 5 - NETWORK PROGRAMMING WITH JAVA	**6 Hrs.**
Network programming with java - Hierarchy of classes in NET package Client Server Programming Concurrent and Iterative server design Introduction of Distributed - Programming in Java RMI Application Designing RMI client & server **Experiments:** 1. Implementation of Client / Server mechanism using Socket classes. 2. Design concurrent server that will handle multiple clients using multithreading. 3. Develop a simple client-server application using RMI. 4. Implement exception related to socket and RMI.	
Module 6 - GRAPHICAL USER INTERFACE IN JAVA	**8 Hrs.**
GUI Design in Java – User Interface Event Handling in Java - Event delegation model (MVC model) Classes supporting event handling Components with swings, Applets, Graphics Programming, Swing Components Tree, Table etc. **Experiments:** 1. GUI design and Event handling 2. Develop an animation program using Multithreading viz. Bouncing Ball. 3. Program to scroll the banner using applet. 4. Program using Applet to illustrate event handling with interactive radio buttons to control font style of a text field. Also provide a text box where in the user may enter font size. 5. Design 8-digit calculator using AWT package and layout managers. 6. GUI design using Swing package - a) Celsius to Fahrenheit conversion b) Login and Password Verification. 7. Implement exception related to event handling, GUI design, applets.	

(SMR)