BANASTHALI VIDYAPITH

Master of Computer Applications
Master of Science (Computer Science)

Curriculum Structure

Master of Computer Applications (MCA)
First Semester Examination, December-2019
Second Semester Examination, April/May-2020
Third Semester Examination, December-2020
Fourth Semester Examination, April/May-2021
Fifth Semester Examination, December-2021
Sixth Semester Examination, April/May-2022

M.Sc. (Computer Science)
First Semester Examination, December-2019
Second Semester Examination, April/May-2020
Third Semester Examination, December-2020
Fourth Semester Examination, April/May-2021

BANASTHALI VIDYAPITH
P.O. BANASTHALI VIDYAPITH
(Rajasthan)-304022

July, 2019

110

No. F. 9-6/81-U.3

Government of India
Ministry of Education and Culture
(Department of Education)

New Delhi, the 25th October, 1983

N O T I F I C A T I O N

In exercise of the powers conferred by Section 3 of the University Grants Commission Act, 1956 (3 of 1956) the Central Government, on the advice of the Commission, hereby declare that Banasthali Vidyapith, P. O. Banasthali Vidyapith, (Rajasthan) shall be deemed to be a University for the purpose of the aforesaid Act.

Sd/-
(M. R. Kolhatkar)
Joint Secretary of the Government of India

N O T I C E

Changes in Bye-laws/Syllabi and Books may from time to time be made by amendment or remaking, and a candidate shall, except in so far as the Vidyapith determines otherwise, comply with any change that applies to years she has not completed at the time of change.

Master of Computer Applications

Programme Educational Objectives

The main objectives of the programme are:

- Department of Computer Science offers the most effective teaching learning methodologies through class room and practical exercises to cultivate an inquisitive mind-set among students.
- The skills and education imparted enables students to utilize new technologies and prepare them for key technology applications and decision-making.
- The MCA program is dedicated to application development and thus, has more emphasis on latest programming languages and tools to develop real world applications.
- Prepare post graduates for productive careers in software industry, corporate sector, Govt. organizations and academia by providing skill based environment for teaching and research in the core and emerging areas of the discipline.
- The programme's thrust is on giving the students a thorough and sound background in theoretical and skill-oriented courses relevant to the latest computer software development.
- Students are trained in the fields of Computational Theory, Programming Languages, Algorithm Design, Application Software Development, Enterprise Resource Planning, Computer Networks, System Administration, Web Designing and Development, Database Administration, Data Mining and Warehousing, and various emerging fields in computer science.
- The programme emphasizes the application of software technology to solve mathematical, computing, communications/networking and commercial problems.
- To apply current tools, technologies and research to create systems for solving industry oriented problems.
- To develop the abilities to face the changing trends and career opportunities in computer applications.
- To embed strong human values and professional ethics for becoming social responsibilities.

Programme Outcomes

After completion of the course, the student will achieve the following:

- **PO1. Domain Knowledge:** Apply the knowledge of mathematics, strong fundamental concepts on data structure, database technologies, Operating systems, algorithmic principles, compiler designs, advanced programming, Software engineering, networking, theoretical computer science in the modeling and design of computer based systems. Also apply the knowledge gained on laboratory experiments.
- **PO2. Problem analysis:** Identify, formulate, and analyze existing algorithms for different real life problems using different domain knowledge
- **PO3. Design/development of solutions:** Design, develop, test and maintain desktop, web, mobile and cross platform software applications using modern tools and technologies that are technically sound, economically feasible, socially and industrially acceptable.
- **PO4. Analyzing Complex problems:** Use domain based knowledge to function effectively on various problems to achieve a common goal to provide effective solutions for complex real life problems using limited resources.
- **PO5. Usage of Modern IT tools:** Use emerging technologies such as Machine learning, cognitive computing, analysis and interpretation of data and simulation tools for problem solving in different computer application domain.
- **PO6. The Professional and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

- **PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10. Communication:** Communicate effectively on complex activities with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11. Project Management:** Demonstrate knowledge of the computer application and management principles to apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change

Master of Science (Computer Science)

Programme Educational Objectives

The main objectives of the programme are:

- The department of computer science follows a unique up-to-date curriculum with the aim of equipping students with strong analytical and technical skills as well as thorough knowledge and expertise in the latest state-of-the art techniques in IT, so that they can work competently in diverse areas including teaching and research and development.
- M.Sc. computer science deals with the theoretical details of hardware and software along with logic & algorithm. Those having a strong computational and scientific background opt for M.Sc. computer science field.
- Prepare skilled and capable professionals with a strong conceptual and practical background in Computer Science.
- Provides an excellent grounding for further research, either through Ph.D. study or in a commercial setting.
- Prepare the students with strong fundamental concepts, analytical capability, programming and problem solving skills.
- Create an ambience of education through faculty training, self learning, sound academic practices and research endeavors.
- Provide opportunities to promote organizational and leadership skills in students through various extra- curricular and co-curricular events.
- Make the students as for as possible industry ready to enhance their employability in the industries.
- Improve department industry collaboration through internship program and interaction with professional society through seminar/workshops.
- Imbibe social awareness and responsibility in students to serve the society and protect environment

Program Outcomes

After completion of the course, the student will achieve the following:

- **PO1. Domain Knowledge:**Apply the knowledge of strong fundamental concepts on data structure, database technologies, Operating systems, algorithmic principles, compiler designs, advanced programming, Software engineering, networking, theoretical computer science in the modeling and design of computer based systems. Also apply the knowledge gained on laboratory experiments.
- **PO2. Problem analysis:** Identify, formulate, and apply standard software engineering practices and strategies in real-time software project development to deliver quality product. Analyze complex real-world problems and devise efficient computer-based solutions
- **PO3. Design/development of solutions:** Design and develop computer programs/computer-based systems using open-source programming environment or commercial environment in the areas related to algorithms, networking, web design, cloud computing, Internet of Things and data analytics of varying complexity.
- **PO4. Analyzing Complex problems:** Use domain based knowledge to function effectively on various problems to achieve a common goal to provide effective solutions for complex real life problems using limited resources. Apply research methods, techniques, and problem solving approaches from the field of research in which they are specializing.
- **PO5. Usage of Modern IT tools:** Use emerging technologies such as Machine learning, cognitive computing, analysis and interpretation of data and simulation tools for problem solving in different computer application domain.
- **PO6. The Professional and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

- **PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10. Communication:** Communicate effectively on complex activities with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11. Project Management:** Demonstrate knowledge of the computer application and management principles to apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change

Curriculum Structure
Master of Computer Applications

Semester - I

Course	Code	Course Name	L	T	P	C *
CS	207	Computer Organization and Architecture	4	0	0	4
CS	413	Computer Oriented Numerical and Statistical Methods	4	0	0	4
CS	440L	Computer Oriented Numerical and Statistical Methods Lab	0	0	4	2
CS	415	Computer Programming	4	0	0	4
CS	415L	Computer Programming Lab	0	0	4	2
CS	434	System Programming	4	0	0	4
CS	437	Web Technology	4	0	0	4
CS	437L	Web Technology Lab	0	0	4	2
Semester Total :			**20**	**0**	**12**	**26**

Semester - II

Course	Code	Course Name	L	T	P	C *
CS	209	Data Structures	4	0	0	4
CS	209L	Data Structures Lab	0	0	4	2
CS	417	Database Management Systems	4	0	0	4
CS	417L	Database Management Systems Lab	0	0	4	2
CS	425	Object Oriented Methodology and Programming	4	0	0	4
CS	425L	Object Oriented Methodology and Programming Lab	0	0	4	2
MATH	302	Introduction to Discrete Mathematics	4	0	0	4
MGMT	421	Management Information System	4	0	0	4
Semester Total :			**20**	**0**	**12**	**26**

Curriculum Structure

Master of Computer Applications - III and IV Semester

Semester - III

Course	Code	Course Name	L	T	P	C *
CS	213	Design and Analysis of Algorithms	4	0	0	4
CS	213L	Design and Analysis of Algorithms Lab	0	0	4	2
CS	308	Operating Systems	4	0	0	4
CS	308L	Operating Systems Lab	0	0	2	1
CS	313	Software Engineering	4	0	0	4
CS	315	Theory of Computation	4	0	0	4
CS	423	Java Programming	4	0	0	4
CS	423L	Java Programming Lab	0	0	4	2
TSKL	401	Communication Skills	2	0	0	2
Semester Total :			**22**	**0**	**10**	**27**

Semester - IV

Course	Code	Course Name	L	T	P	C *
CS	302	Data Communications and Networks	4	0	0	4
CS	406	Compiler Design	4	0	0	4
CS	419	Distributed Computing	4	0	0	4
CS	430P	Project	0	0	8	4
CS	447S	Seminar	0	0	4	2
CS	436	Web Development and .NET Framework	4	0	0	4
CS	436L	Web Development and .NET Framework Lab	0	0	8	4
		Semester Total :	**16**	**0**	**20**	**26**

Curriculum Structure

Master of Computer Applications - V and VI Semester

Semester - V

Course	Code	Course Name	L	T	P	C*
CS	411	Computer Graphics	4	0	0	4
CS	537L	Computer Graphics Lab	0	0	6	3
CS	507	Artificial Intelligence	4	0	0	4
CS	508	Big Data Analytics	4	0	0	4
CS	536L	Big Data Analytics Lab	0	0	6	3
		Discipline Electives	4	0	0	4
		Open Electives	4	0	0	4
		Semester Total :	**20**	**0**	**12**	**26**

List of Discipline Elective

Course	Code	Course Name	L	T	P	C *
CS	427	Parallel Computing	4	0	0	4
CS	431	Real Time Systems	4	0	0	4
CS	433	Soft Computing	4	0	0	4
CS	511	Cloud Computing	4	0	0	4
CS	519	Data Warehouse and Data Mining	4	0	0	4
CS	527	Mobile Computing	4	0	0	4
CS	528	Modeling and Simulation	4	0	0	4
CS	529	Natural Language Processing	4	0	0	4
CS	601	Cyber Security	4	0	0	4
CS	602	Digital Image Processing	4	0	0	4
ELE	304	Digital Signal Processing	4	0	0	4
IT	506	Human Computer Interaction	4	0	0	4

Semester - VI

Course	Code	Course Name	L	T	P	C
		Reading Elective	0	0	0	2
CS	449P	UILProject	0	0	48	24
	Semester Total :		**0**	**0**	**48**	**26**

List of Reading Elective

Course	Code	Course Name	L	T	P	C *
CS	509R	Client - Server Computing and Applications	0	0	0	2
CS	522R	Electronic Commerce	0	0	0	2
IT	403R	Enterprise Resource Planning	0	0	0	2
		Agile Software Development	0	0	0	2
		Organizational Behavior	0	0	0	2
		Software as a Service	0	0	0	2
		Blockchain	0	0	0	2

*** L - Lecture hrs/week; T - Tutorial hrs/week; P-Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C - Credit Points of the Course**

Student can opt open (Generic) elective from any discipline of theVidyapith with prior permission of respective heads and time table permitting.

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II,
Five Fold Education: Aesthetic Education I, Aesthetic Education II,
Five Fold Education: Practical Education I, Practical Education II
one each semester

Curriculum Structure

Master of Science (Computer Science)

Semester - I

Course	Code	Course Name	L	T	P	C *
CS	213	Design and Analysis of Algorithms	4	0	0	4
CS	213L	Design and Analysis of Algorithms Lab	0	0	4	2
CS	308	Operating Systems	4	0	0	4
CS	308L	Operating Systems Lab	0	0	2	1
CS	313	Software Engineering	4	0	0	4
CS	315	Theory of Computation	4	0	0	4
CS	423	Java Programming	4	0	0	4
CS	423L	Java Programming Lab	0	0	4	2
TSKL	401	Communication Skills	2	0	0	2
	Semester Total :		**22**	**0**	**10**	**27**

Semester - II

Course	Code	Course Name	L	T	P	C *
CS	302	Data Communications and Networks	4	0	0	4
CS	406	Compiler Design	4	0	0	4
CS	419	Distributed Computing	4	0	0	4
CS	430P	Project	0	0	8	4
CS	432S	Seminar	0	0	4	2
CS	436	Web Development and .NET Framework	4	0	0	4
CS	436L	Web Development and .NET Framework Lab	0	0	8	4
	Semester Total :		**16**	**0**	**20**	**26**

Semester - III

Course	Code	Course Name	L	T	P	C *
		Discipline Elective	4	0	0	4
		Open Elective	4	0	0	4
CS	411	Computer Graphics	4	0	0	4
CS	507	Artificial Intelligence	4	0	0	4
CS	508	Big Data Analytics	4	0	0	4
CS	508L	Big Data Analytics Lab	0	0	6	3
CS	516L	Computer Graphics Lab	0	0	6	3
	Semester Total :		**20**	**0**	**12**	**26**

List of Discipline Elective

Course	Code	Course Name	L	T	P	C *
CS	427	Parallel Computing	4	0	0	4
CS	431	Real Time Systems	4	0	0	4
CS	433	Soft Computing	4	0	0	4
CS	511	Cloud Computing	4	0	0	4
CS	519	Data Warehouse and Data Mining	4	0	0	4
CS	527	Mobile Computing	4	0	0	4
CS	528	Modeling and Simulation	4	0	0	4
CS	529	Natural Language Processing	4	0	0	4
CS	601	Cyber Security	4	0	0	4
CS	602	Digital Image Processing	4	0	0	4
ELE	304	Digital Signal Processing	4	0	0	4
IT	506	Human Computer Interaction	4	0	0	4

Semester - IV

Course	Code	Course Name	L	T	P	C
		Reading Elective	0	0	0	2
CS	534P	UIL Project	0	0	48	24
	Semester Total :		**0**	**0**	**48**	**26**

List of Reading Elective

Course	Code	Course Name	L	T	P	C *
CS		Client - Server Computing and Applications	0	0	0	2
CS		Electronic Commerce	0	0	0	2
IT	403R	Enterprise Resource Planning	0	0	0	2
IT		Agile Software Development	0	0	0	2
IT		Organizational Behavior	0	0	0	2
IT		Software as a Service	0	0	0	2
IT		Blockchain	0	0	0	2

*** L - Lecture hrs/week; T - Tutorial hrs/week; P-Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C - Credit Points of the Course**

Student can opt open (Generic) elective from any discipline of theVidyapith with prior permission of respective heads and time table permitting.

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II,
Five Fold Education: Aesthetic Education I, Aesthetic Education II,
Five Fold Education: Practical Education I, Practical Education II
one each semester

Five Fold Activities

Fine Arts		Physical Education and Sports	
BVFF 101	Classical Dance (Bharatnatyam)	BVFF 201	Aerobics
BVFF 102	Classical Dance (Kathak)	BVFF 202	Archery
BVFF 103	Classical Dance (Manipuri)	BVFF 203	Athletics
BVFF 104	Creative Art	BVFF 204	Badminton
BVFF 105	Folk Dance	BVFF 205	Basketball
BVFF 106	Music-Instrumental (Guitar)	BVFF 206	Cricket
BVFF 107	Music-Instrumental (Orchestra)	BVFF 207	Equestrian
BVFF 108	Music-Instrumental (Sarod)	BVFF 208	Flying - Flight Radio Telephone Operator's Licence (Restricted)
BVFF 109	Music-Instrumental (Sitar)	BVFF 209	Flying - Student Pilot's Licence
BVFF 110	Music-Instrumental (Tabla)	BVFF 229	Aeromodelling
BVFF 111	Music-Instrumental (Violin)	BVFF 210	Football
BVFF 112	Music-Vocal	BVFF 211	Gymnastics
BVFF 113	Theatre	BVFF 212	Handball
		BVFF 213	Hockey
Social Service and Extension Activities		BVFF 214	Judo
BVFF 301	BanasthaliSewa Dal	BVFF 215	Kabaddi
BVFF 302	Extension Programs for Women Empowerment	BVFF 216	Karate – Do
BVFF 303	FM Radio	BVFF 217	Kho-Kho
BVFF 304	Informal Education	BVFF 218	Net Ball
BVFF 305	National Service Scheme	BVFF 219	Rope Mallakhamb
BVFF 306	National Cadet Corps	BVFF 220	Shooting
		BVFF 221	Soft Ball
		BVFF 222	Swimming
		BVFF 223	Table Tennis
		BVFF 224	Tennis

	BVFF 225	Throwball
	BVFF 226	Volleyball
	BVFF 227	Weight Training
	BVFF 228	Yoga

Evaluation Scheme and Grading System

ContinuousAssessment(CA) (Max. Marks)					End-SemesterAssessment (ESA) (Max.Marks)	GrandTotal (Max. Marks)
Assignment		Periodical Test		Total (CA)		
I	II	I	II			
10	10	10	10	40	60	100

In all theory, laboratory and other non classroom activities (project, dissertation, seminar, etc.), the Continuous and End-semester assessment will be of 40 and 60 marks respectively. However, for Reading Elective, only End semester exam of 100 marks will be held. Wherever desired, the detailed breakup of continuous assessment marks (40), for project, practical, dissertation, seminar, etc shall be announced by respective departments in respective student handouts.

Based on the cumulative performance in the continuous and end-semester assessments, the grade obtained by the student in each course shall be awarded. The classification of grades is as under:

LetterGrade	GradePoint	Narration
O	10	Outstanding
A+	9	Excellent
A	8	VeryGood
B+	7	Good
B	6	AboveAverage
C+	5	Average
C	4	BelowAverage
D	3	Marginal
E	2	Exposed
NC	0	NotCleared

Based on the obtained grades, the Semester Grade Point Average shall be computed as under:

$$SGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of courses (with letter grading) registered in the semester, CC_i are the course credits attached to the i^{th} course with letter grading and GP_i is the letter grade point obtained in the i^{th} course. The courses which are given Non-Letter Grades are not considered in the calculation of SGPA.

The Cumulative Grade Point Average (CGPA) at the end of each semester shall be computed as under:

$$CGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of all the courses (with letter grading) that a student has taken up to the previous semester.

Student shall be required to maintain a minimum of 4.00 CGPA at the end of each semester. If a student's CGPA remains below 4.00 in two consecutive semesters, then the student will be placed under probation and the case will be referred to Academic Performance Review Committee (APRC) which will decide the course load of the student for successive semester till the student comes out of the probationary clause.

To clear a course of a degree program, a student should obtain letter grade C and above. However, D/E grade in two/one of the courses throughout the UG/PG degree program respectively shall be deemed to have cleared the respective course(s). The excess of two/one D/E course(s) in UG/PG degree program shall become the backlog course(s) and the student will be required to repeat and clear them in successive semester(s) by obtaining grade C or above.

After successfully clearing all the courses of the degree program, the student shall be awarded division as per following table.

Division	CGPA
Distinction	7.50andabove
FirstDivision	6.00to 7.49
SecondDivision	5.00to 5.99

Pass	4.00to4.99

CGPA to % Conversion Formula: % of Marks Obtained = CGPA * 10

First Semester

CS 207 Computer Organization and Architecture

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Perform computer arithmetic operations.
- Use the concepts and design of all type of sequential and combinational circuits.
- Design and conduct experiments, as well as to analyze of the hardware of a computer system and its components such as control unit, arithmetic and logical (ALU) unit, input/output, and memory unit.
- Design techniques such as pipelining and microprogramming in the design of the central processing unit of a computer system.
- Understand the concept of I/O organization.

Section-A

Brief introduction to computer organization, representation of data, bits and bytes, Number system (binary, octal, decimal, hexadecimal), Representation of integers, real numbers, positive and negative numbers. Binary arithmetic, simple concepts and theorems of Boolean Algebra.

Representation of character: BCD, ASCII, EBCDIC Codes, Self Complementary Codes, Error Detecting Codes and Error correcting codes (Parity, Gray & Hamming Codes).

Logic Gates and Boolean Algebra, Karnaugh Map, Combinational Circuit Design: Adder, Subtractor, Decoder, Demultiplexer, Encoder, Multiplexer, Comparator.

Section-B

Basics of logic families, Sequential Circuits, Flip-Flop, Shift Register, Asynchronous and Synchronous Counters.

Semiconductor Memories: Types of Memories, Sequential and Random Access Memory (RAM, ROM, PROM, EPROM) Storage location and address, fixed and variable word length storage, Cache Memory, bubble memory, Secondary Memory devices and their characteristics.

Section-C

Data bus and address bus, stack organization, various registers, instruction formats, various addressing techniques.

I/O Organization-Simple I/O devices and their properties, device interfacing, DMA interface, program & interrupt control transfer.

CPU Organization : Design of ALU, Magnitude comparator, design of shifter and accumulator, Status Register, Processor unit, Control unit organization, Hardware and Micro-porgrammed control, Firmware, Control of Processor unit, Microprogram sequencer.

Suggested Books:

1. Mano, M. M. (2007). *Computer System Architecture* (3rd ed.). Pearson Education.
2. Mano, M. M. (2017). *Digital Logic and Computer Design*. Pearson Education.
3. Leach, D. P., Malvino, A.P., & Saha G.*Digital Principles and Applications*(6th ed.). Tata Mc-Graw Hill.
4. Malvino & Brown.*Digital Computer Electronics*(3rd ed.).Tata McGraw Hill.
5. Floyd and Jain.*Digital Fundamentals (8th ed.).* Pearson Education.
6. W. Stallings.*Computer Organization and Architecture* (7th ed.). Pearson Education.

Suggested E-Resources:

1. Computer Organizations and Architecture by William Stallings

   http://williamstallings.com/ComputerOrganization/
2. The Computing Technology inside Your Smartphone by Cornell University

https://www.edx.org/course/computing-technology-inside-smartphone-cornellx-engri1210x-0

3. Computer Organizations and Architecture

https://nptel.ac.in/courses/106103068/

CS 413Computer Oriented Numerical and Statistical Methods

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Using appropriate numerical methods, determine the solutions to given non-linear equations, systems of linear equations, interpolation, numerical differentiation and integration and numerical solution of ordinary differential equations.
- Analyze the errors obtained in the numerical solution of problems.
- Apply appropriate algorithms to solve selected problems, both manually and by writing computer programs.
- Compare different algorithms with respect to accuracy and efficiency of solution.
- Implement numerical methods algorithm using programming language.

Section-A

Errors and Approximations in Digital Computers, Number representation, Floating point Arithmetic. Solution of systems of linear equations - direct method, Gauss Jordan & Gauss Elimination methods, Pivoting, Iterative methods - Jacobi & Gauss Seidel method.

Solution of Nonlinear equations in n variable : Localization of the roots, Bisection and Regula-Falsi methods, Newton-Raphson method, Secant method successive Approximation method, Rate of convergence and Aitkin's process.

Section-B

Interpolation: Newton's Interpolation formulae - Forward and Backward difference formulae, Lagrange's and Divided difference Interpolation formula, Error term and error of Interpolation, Inverse Interpolation. Numerical Differentiation and Integration: Differentiation formula based on Interpolating polynomials- Newton-Gregory Forward, Backward and Divided difference Polynomial, Newton-Cotes formulae - Trapezoidal & Simpson's rule, change of interval of integration.

Numerical solution of ordinary Differential equations : ODE's as a system of first order ODE's, Euler's, Picard's and Taylor series methods of real functions, Runge-Kutta 2nd order method, Runge-kutta 4th order method. Modified Euler's Method, Predictor-corrector method. Polynomial Approximations, Least squares approximation.

Section-C

Statistical methods: treatment of data, frequency distribution, measures of central tendency, dispersion and partition values .Probability distribution-Binomial, Poisson and Normal. Correlation and regression.

Inference- test of significance for large sample only (mean, variance, proportion),chi-square test for goodness of fit and Independence of attributes. Analysis of variance, analysis of covariance.

Suggested Books:

1. Rajaraman, V. (1993).*Computer Oriented Numerical Methods* (3rd ed.). PHI Learning, New Delhi.
2. Cheney E.W. & Kincaid D.R. (2008).*Numerical Methods and Applications*. Cengage Learning, New Delhi.
3. Gupta, S.P. (2008).*Statistical Method*s (11th ed.). Sultan Chand &Sons, New Delhi.
4. Gupta, S.C.& Kapoor, V. K. (2002). *Fundamentals of Mathematical Statistics*(11th ed.). Sultan Chand &Sons, New Delhi.
5. Krishnamurthy, E.V. & Kumar S.S. (1976). *Computer Based Numerical Algorithms*. East West Press, New Delhi.
6. Rao, K.S. (2007).*Numerical Method for Scientists and Engineers.* PHI Learning Pvt. Ltd., New Delhi.
7. Sastry, S.S. (2008).*Introductory Methods of Numeric Analysis*(4th ed.).PHI Learning Pvt. Ltd., New Delhi.
8. Yule, G.U. & Kendall, M.G. *An Introduction to the Theory of Statistics*, Universal Book Stall.
9. Agarwal, B.L.*Basic Statistics.* New Age International Publication.

Suggested E-Resources:

1. Computer Oriented Numerical and Statistical Methods
   https://nptel.ac.in/courses/122106033/#
2. Computer Oriented Numerical and Statistical Methods MOOC website
   https://www.mooc-list.com/tags/numerical-methods

CS 440LComputer Oriented Numerical and Statistical Methods Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Lab No.	**Problems**
L01	Perform floating point operations using normalization (addition, subtraction, multiplication, division)
L02-L03	Find the roots of equation (bisection method, regula-falsi method, Newton raphson method, secant method, successive approximation method)
L04-L05	Find solution of n linear equation (Gauss elimination method (with & without pivoting). Gauss Seidel method. Gauss Jordan method
L06	Generate following difference tables (forward, backward, divided difference)
L07-L09	Interpolate value of f(x) at given x (Lagrange's interpolation method, Newton forward interpolation method, Newton's backward interpolation method), Inverse interpolation
L10-L11	Fitting of different curves (straight line fit (x on y), straight line fit (y on x), parabola, geometric curve, exponential curve)
L12- L13	Find derivative of a given tabulated function at given value (Newton's forward method, Newton's backward method)
L14 – L16	Find Integrated value, (when tabulated function given-Trapezoidal rule (simple & modified), Simpson's 1/3 (simple & modified), Simpson's 3/8 (simple & modified)
L17 – L19	Find Integrated value, when algebraic expression given (when algebraic expression given-Trapezoidal rule (simple & modified), Simpson's 1/3 (simple & modified), Simpson's 3/8 (simple & modified).

L20-L21	Solve differential equation (Euler's method, Runge-Kutta 2nd order method, Runge-kutta 4th order method. Modified Euler's method, Predictor-corrector method.
L22-L23	Determination of Mean, Median, Mode, G.M., H.M., Quartiles, Deciles and Percentiles.
L24-L25	Computation of Range, Standard deviation, Mean deviation, Quartile deviation and Coefficient of variation.
L26	Computation of coefficients of correlation and rank correlation.
L27-L28	Fitting of (i) Binomial, (ii) Poisson
L29	Test of Significance problems for Large sample testing
L30-L31	Chi Square test for goodness of fit and independence of attributes
L32	ANOVA for one way classification.

CS 415 Computer Programming

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Understanding the concepts of computer basics and programming.
- Understanding of the organization and operations of a computer system.
- Understanding of Binary logic in design of electronic circuits.
- Students would have logical thinking for Analyzing problems, designing and implementing algorithmic solutions.
- Students would get the skills for the use of the C programming language to implement the real world applications.

Section-A

Fundamentals of Computer System: Block Diagram, CPU, Memory, Input/Output Devices. Hardware and Software, Booting Process and DOS Commands.

Steps in Program Development: Problem analysis, algorithms & flow charts, High level and low level programming languages.

Computer Programming Using C: History, Data types (simple and structured) and their representation, Constants and variables, Operators, Arithmetic's and logical expressions, Type casting, Input and output statements.

Section-B

Control Statements: Sequencing, Conditional and unconditional branching and looping.

Arrays: Single and multidimensional arrays, Arrays and strings, String built-in functions, Applications of arrays: Searching (linear and binary), Sorting (bubble, selection and insertion).

Structured Programming: Function declaration and definition, Function call, Passing parameters to the functions: call by value, call by reference. Returning values, Recursive functions, Passing arrays to functions.

Section-C

Storage classes in C: Automatic, Register, External, and Static.

Pointers: Pointer arithmetic, Pointers and arrays, Pointers and strings, Pointer to pointer, Dynamic Memory Allocation.

Derived Data Types: Structures, unions, Array of structure, Pointer to structure, enumerated data types.

File Handling in C: Types of files,Opening and closing a data file, reading and writing a data file, Random access in a file, Error handling during file I/O operations, Command line arguments.

Suggested Books:

1. Kanetkar, Y. P. (2009).*Let us C*. BPB Publications.
2. Sinha,P. K. (2004).*Computer Fundamentals: Concept, Systems and Applications*. BPB Publications.
3. Kernighan, B. W., & Ritchie, D. M. (2006). *The C Programming Language*. PHI Learning Pvt. Ltd., New Delhi.
4. Kanetkar, Y. P. (2009). *Understanding Pointers in C*. BPB Publications.
5. Dromey, R. G. (2007).*How to Solve it by Computer*.PHI Learning Pvt. Ltd . New Delhi.

6. Govil, Mahesh Chand, *Computer Fundamentals and Programming in C*, Jaipur Publishing House.
7. NIIT, *Introduction to Computer Programming*(2005*)*.PHI Learning Pvt. Ltd . New Delhi.
8. Venugopal, K. R. (2005). *Programming with C*. Tata McGraw-Hill.
9. Balagurusamy, E., (2010). *Programming in ANSI C*. Tata McGraw-Hill.

Suggested E-Resources:

1. Introduction to Programming in C
   https://nptel.ac.in/courses/106104128/
2. Introduction to Programming in C Specialization by Duke University
   https://www.coursera.org/specializations/c-programming
3. Computer Fundamentals by P. K. Sinha
   https://www.edutechlearners.com/computer-fundamentals-p-k-sinha-free-pdf/

CS 415L Computer Programming Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Lab Number	**Problems**
L1-L3	Simple hands on computers and DOS Internal & External Commands
L4-L6	Simple Problems Using scanf and printf functions. Formula Based Problems using Constants, Variables and use of operators.
L7-L8	Use of Library Functions e.g. sqrt, sin, cos, log etc.
L9-L20	Loop Statement using for, while, do –while statement
L21-L25	Conditional Checking Using if statement, Nested if statement, switch statement and Unconditional goto
L26-L40	Problems based on array data types. Problems on One Dimensional Array-Searching (Linear, Binary), Sorting (Bubble, Selection, Insertion), Merging.
L41-L45	Problems on two Dimensional Array -Matrix Operation: Addition, Subtraction, Multiplication etc.
L46-L50	Problems based on pointers, Parameter passing in functions, Recursion
L51-L55	Declaration, Reading, Writing and manipulation on struct and union data type
L56-L62	File handling
L63-L64	Command line Arguments

CS 434 System Programming

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Understand the basics of system programs like editors, compiler, assembler, linker, loader, interpreter and debugger.
- Describe the various concepts of assemblers and macro-processors.
- Understand the various phases of compiler and compare its working with assembler.
- Understand how linker and loader create an executable program from an object module created by assembler and compiler.
- Know various editors and debugging techniques.

Section-A

System Software: Components and Evolution. General Machine Structure: Memory, Instructions, Registers.

Operating Systems: Types & basic functions. Assemblers: Elements of Assembly Language Programming, A Simple Assembly Scheme, Pass Structure of Assemblers, Design of 2 pass assembler.

Section-B

Macros and macro processors: Macro Definition and Call, Macro Expansion, Nested Macro Calls, Design of a Macro Preprocessor. Loaders and linkers: Loader schemes (Compile and go loader, general loader scheme, absolute loader, subroutine linkage, relocating loader, direct linking loader, binders and overlays).

Section-C

Software Tools: Editors, Debug Monitors, Program generators Translators: Interpreters, Compiler: Brief description of different phases. ROM BIOS, EMS, input and output services. Device Drives: Types, structure and processing. Interrupt: Types, Organization, processing, IVT, interrupt handler.

Suggested Books:

1. Donovan J.J (1991). *Systems Programming*. Tata Mc-Graw Hill.
2. Dunkan R (1994).*Advance MS-DOS Programming*, BPB Publications.
3. Elzeey Roy S. (1987).*Computer System Software*, Science Research Associates.
4. Dhamdhere D.M. (1987). *Introduction to System Software*. Tata Mc-Graw Hill.
5. Bigger Staff T. J.(1986). *System Software Tools*, PHI Learning Pvt. Ltd . New Delhi.
6. Dhamdhere D.M (2001).*System Programming and Operating Systems*(2nd ed.). Tata Mc-Graw Hill.
7. Bose S.K. (1991). *Hardware and Software of Personal Computers*. New Age International Publishers.

Suggested E-Resources:

1. System Programming by Leland L. Beck
   http://solomon.ipv6.club.tw/Course/SP.941/

CS 437Web Technology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Understand working of Internet & World Wide Web.
- Develop a dynamic webpage by the use of java script, HTML & CSS.
- Develop an application using Javascript.
- Develop web application using PHP with database connectivity.
- Get the knowledge of publishing and hosting web application.

Section-A

Internet: Concept of Networking, Applications, Evolution of Internet, Basic Internet services, WWW, Concept of Web browser, Web server, Domain Name Server (DNS), URL, HTTP, Internet Service Providers, Search engines, Cookies, Basics of Web site design, Characteristics of a good website, Web hosting and Web publishing, Web crawlers, Introduction to Web Design Tools (Front page, Dreamweaver).

HTML: Introduction, Elements, Structure of HTML code, Attributes, Headings, Paragraphs, Styles, Formatting, Lists, Quotations, Links, Images, Tables, Forms, Frame, DHTML.

Section-B

Cascading Style Sheets (CSS): Syntax, Internal, External and Embedded CSS. CSS: Text, Fonts, Links, Tables, Border, Outline, Margin, Class Selector, ID Selector.

JavaScript: Introduction, Syntax, Data types, Variables, Expressions, Operators, Conditional statements, Looping structures: while, do while, for. Arrays, Functions, Forms and validations, Event Handling, DOM of JavaScript, JavaScript objects.

Section-C

PHP Introduction: Origin, PHP with the Web Server, syntax, data types, variables, constant, expression, operator, Control structure, Loops, Functions, argument passing in functions, References, Pass by Value & Pass by references, Return Values, Variable Scope, Array, Form handling, String handling, Cookies and Sessions, Basics of MySql, Connectivity with MySql.

Suggested Books:

1. Deborah S. Roy &Eric J. Roy.*Mastering HTML 4.0*. BPB Publications.
2. Bayross I. (2009).*Web Enabled Commercial Applications Development Using HTML, DHTML and PHP* (4th ed.). BPB Publications.
3. Holzner, S. (2008). *PHP: The Complete Reference*. Tata McGraw-Hill.
4. P.J. Deitel,& H.M. Deitel.*Internet and World Wide Web How to Program*, Pearson Education.

5. Greenlaw, R., & Hepp, E. (2001). *Fundamentals of the Internet and the World Wide Web*(2nd ed.*)*. Tata McGraw-Hill.

Suggested E-Resources:

1. W3Schools website

   https://www.w3schools.com/xml/

2. HTML, CSS, and Javascript for Web Developers by Johns Hopkins University

   https://www.coursera.org/learn/html-css-javascript-for-web-developers

3. Internet Technology by IIT Kharagpur

   https://nptel.ac.in/courses/106105084/

CS 437LWeb Technology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Lab Number	**Problems**
L1-L2	Create a page with HTML basic tag like, Paragraph, formatting, inserting image
L3	Create different types of list using HTML
L4	Create pages with internal and external linking using HTML
L5-L6	Create different types of tables using HTML
L7	Create different types of image maps using HTML
L8-L9	Create pages with different frame formats using HTML
L10-L11	Create pages using HTML form, CSS Introduction
L12- L14	Types of CSS Designing a web page using Font Tables and Link in CSS and HTML
L15	Create a pages using DIV
L16	Create a pages using Class and ID Selector
L17-18	Java Script Introduction, Use of data types, variables, constant, Expression, operator in Java Script
L19-L21	Use of conditional statements in Java Script
L22-L24	Use of looping statements in Java Script

L25-26	Java Script functions
L 27- L28	Java Script DOM and Event in Java Script
L29-L30	PHP Introduction, Use of data types, variables, constant, Expression, operator
L31	Use of conditional statements in PHP
L32-L33	Use of looping statements in PHP
L34-L35	Creating different types of arrays
L36-37	Usage of array functions
L38-39	Creating user defined functions, Functions Call by value and call by reference
L40	Form handling using GET, POST
L41	Creation of sessions, Cookies
L 42	Creating web page using QueryString and Hidden Field
L43- L45	Database Connectivity, ADD, DELETE, UPDATE and VIEW data from database

Second Semester

CS 209 Data Structures

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

On successful completion of the course students will be able to

- Develop knowledge of basic data structures for storage and retrieval of ordered or unordered data. Data structures include: arrays, linked lists, stacks, queues, binary trees, heaps.
- Develop knowledge of applications of data structures including the ability to implement algorithms for the creation, insertion, deletion, searching, and sorting of each data structure.
- Learn to analyze and compare algorithms for efficiency using Big-O notation.
- Understand the concept of Dynamic memory management, data types, algorithms, Big O notation.
- Apply Algorithm for solving problems like sorting, searching, insertion and deletion of data

Section-A

Concept of data types, Abstract data type, Data structures, running time of a program, asymptotic notations: Big-Oh, Theta, Little-oh, Omega.

Linear data structures: Static implementation of stack, queue, and their applications

Searching and Sorting: Linear search and Binary Search, Bubble sort, Selection sort, Insertion sort, Quick sort, Radix sort.

Section-B

Linked List: Linear, doubly or two way, circular, header and various operations; Representation of polynomial using linked list, addition and subtraction of polynomials. Dynamic implementation of stacks and queues.

Dynamic memory management: fixed and variable block storage, storage techniques: first-fit, best-fit, worst-fit, next-fit; data compaction, and garbage collection.

Section-C

Non linear data structures: Tree concepts, General Tree, binary tree and types, binary search tree, implementation of various operations on Binary Search Tree (tree traversal, searching, insertion and deletion, counting leaf and non-leaf nodes, height).

Suggested Books:

1. Langsam, Y., Augenstein, M., & Tenenbaum, A. M. *Data Structures using C and C++*. PHI Learning, New Delhi.
2. Tremblay, J. P., & Sorenson, P. G. (1985). *An Introduction to Data Structures with Applications*. Tata McGraw-Hill.
2. Horowitz E. & S. Sahni (2009).*Fundamentals of Data Structures*. University Press.
3. A.V. Aho, J.E. Hopecraft & J.D. Ullman (1987).*Data Structures and Algorithms*. Addition –Wesley Publishing Co.
4. Lipschutz, Seymour. *Schaum's Outline of Theory and Problems of Data Structures*.Tata McGraw-Hill.

Suggested E-Resources:

1. Programming and Data Structures
   https://swayam.gov.in/course/1407-programming-and-data-structures
2. Data Structures and Program Methodology
   https://nptel.ac.in/courses/106103069/

CS 209L Data Structures Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Lab Number	**Problems**
L1-L10	Programs based on static implementation of stacks and its application
L11-L18	Programs based on static implementation of queues (simple, circular, priority, dequeue) .
L19-L30	Operations on Singly, Doubly & Circular Linked lists. Dynamic implementation of stacks and queues.
L31-L40	Operations on Binary tree, binary search tree

CS 417 Database Management Systems

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

On successful completion of the course students will be able to

- Describe data models and schemas in DBMS
- Understand the features of database management system and Relational databases.
- Use SQL -the standard language of relational databases.
- Understand the functional dependencies and design of the database.
- Understand the concept of Transaction and Query processing.

Section-A

Introduction : Database system concepts and architecture, Data models schema and instances, Data independence and database language and interface, Data definition languages, DML, Overall database structure.

Data modeling using Entity Relationship Model : E. R. model concepts, notation for ER diagrams, mapping constraints, Keys, Concept of super key, candidate key, primary key, Generalization, Aggregation, reducing ER diagrams to tables, extended ER model, Relationship of higher degree.

Relational Data Model and Language : Relational data model concepts, relational algebra, relational calculus, tuple and domain calculus, SQL, data definition queries and updates in SQL, integrity constraints, Keys-constraints, domain constraints, referential integrity, assertions, security of databases.

Section-B

Example DBMS System (Oracle 8) : Basic architecture, data definition and data manipulation, ISQL, PLSQL, cursors, triggers, stored procedures.

Database design : Functional dependencies, normal forms, first, second and third functional personal normal forms. BCNF, multivalued dependencies, fourth normal forms, join dependencies and fifth normal forms. Steps in database design.

Query processing: Steps of Query Processing, Measures of Query Cost, Selection Operation, Sorting, Join Operation, Evaluation of Expressions.

Section-C

Query Optimization: Catalog Information for Cost Estimation, Estimation of Statistics, Transformation of Relational Expressions, Dynamic Programming for Choosing Evaluation Plans.

Transaction processing concepts. Concurrency control techniques, locking techniques, and time stamping and concurrency control.

Recovery-Log-Based, Shadow Paging, Recovery with concurrent Transactions Distributed databse systems: Fragments of Relations, Optimization transmission cost by semi joins, Distributed concurrency control, Management of deadlocks.

Suggested Books:

1. Korth Henry F., Silberschatz Abraham, &Sudarshan S. (2006). *Database System Concepts*(5th ed.). Tata McGraw-Hill.
2. Murdick, R. G., Ross, J. E., & Claggett, J. R. *Information Systems for Modern Management*. Prentice Hall Professional Technical Reference.
3. Date C.J. *An Introduction to Database Systems.* Addison Wesley.
4. Majumdar & Bhattachrya.*Database Management System*. Tata McGraw-Hill.
5. Ramakrishnan, R., & Gehrke, J. (2000). *Database Management Systems*. Tata McGraw-Hill.
6. Leon, A., & Leon, M. (2010). *Database Management Systems*. Vikas Publishing House Pvt. Limited.

Suggested E-Resources:

1. Data Base Management System

   https://nptel.ac.in/courses/106105175/
2. Database Management Essentials by University of Colorado

   https://www.coursera.org/learn/database-management
3. Database System Concepts by Abraham Silberschatz, Henry F. Korth and S. Sudarshan

   https://kakeboksen.td.org.uit.no/Database%20System%20Concepts%206th%20edition.pdf

CS 417L Database Management Systems Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	4	2

Lab	Problem
1-5	Basic DDL commands(Create,Drop,Alter) with integrity constraints
6-10	DML & DCL commands (Insert, Update, Delete, Select, Commit, Rollback)
11-13	Operators (Arithmatic,Logical,Relational etc.)
14-18	Assignment based on DDL and DML with conditions also Joins (Self join, inner join, outer join, equi join)
19-20	Complex queries (Retrieval of data from more than one table)
21-25	PL/SQL Block,Loops
26-27	Cursors, Triggers, Procedure, Function
28	Assignment of PL/SQL
29-32	Forms and report using front and tool. Connecting of database

CS 425 Object Oriented Methodology and Programming

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

On successful completion of the course students will be able to

- Understand the features of C++ supporting object oriented programming
- Understand the relative merits of C++ as an object oriented programming language
- Understand how to produce object-oriented software using C++
- Understand how to apply the major object-oriented concepts to implement object oriented programs in C++, encapsulation, inheritance and polymorphism

- Understand advanced features of C++ specifically stream I/O, templates and operator overloading
- Understand other features of the C++ language including templates, forms of casting, conversions, and file handling.

Section-A

Object-Oriented Methodology: Differences from Functional Methodology, Abstraction, Encapsulation, Object Modeling Technique, Objects, Classes, Object Diagrams, Attributes, Operations and Methods, Links, Associations, Multiplicity, Generalization and Inheritance, Aggregation, Abstract Classes, Multiple Inheritance

C++: Tokens, Data Types, Operators and Expressions, Promotion and Type Conversion, Operator Precedence and Associativity, Conditional and Looping Constructs, Operations on Arrays, Strings Manipulations, Function Components, Parameter Passing, Return by Reference, Default Arguments, Inline Functions, Function Overloading, Arrays and Functions, Scope and Extent of Variables, Storage Classes, Functions with Variable Number of Arguments, Recursive Functions, Class Specification, Class Objects, Data Hiding, Empty Classes, Passing Objects as Arguments, Returning Objects from Functions.

Section-B

Friend Functions and Friend Classes, Constant Parameters and Member Functions, Static Data and Member Functions, Constructors, Destructor, Constructor Overloading, Constructors with Default Arguments, Nameless Objects, Dynamic Initialization through Constructors, Copy Constructor, Constant Objects and Constructor, Static Data Members with Constructors and Destructors, Pointers and their Binding, void Pointers, Runtime Memory Management, Pointer Constants, Pointers to Constant Objects, Constant Pointer, Pointers to Objects, Live Objects, Array of Objects, this Pointer, Unary Operator Overloading, Increment/ Decrement Operators, Binary Operator Overloading, Arithmetic Operators, Concatenation of Strings, Comparison Operators, Arithmetic Assignment Operators, Overloading of new and delete Operators, Data Conversion, Overloading with Friend Functions, Assignment Operator Overloading, Inheritance and Member Accessibility, Constructors and Destructors in Derived Classes,

Constructors Invocation and Data Member Initialization, Overloaded Member Functions, Abstract Classes, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Multipath Inheritance and Virtual Base Classes, Hybrid Inheritance.

Section-C

Virtual Functions, Pointer to Derived Class Objects, Pure Virtual Functions, Abstract Classes, Dynamic Binding Implementation, Function Templates, Overloaded Function Templates, Nesting of Function Calls, Multiple Arguments Function Template, User Defined Template Arguments, Class Templates, Inheritance of Class Template, Class Template Containership, Class Template with Overloaded Operators, Console I/O, Concept of Streams, Hierarchy of Console Stream Classes, Unformatted and Formatted I/O Operation, Managing Output with Manipulators, File Handling, Classes for File Stream Operation, Open and Close a File, File Models, File Pointers and their Manipulations, Sequential I/O Operations, Updating a File, Error Handling during File Operation, Exception Handling, Use of Standard Template Library (STL).

Suggested Books:

1. Rumbaugh, J., Blaha, M., Premerlani, W., Eddy, F., & Lorensen, W. E. (1991). *Object-oriented Modeling and Design*. PHI Learning, New Delhi.
2. Venugopal, K.R., Buyya, Rajkumar, &Ravishankar (1997).*Mastering C++*. Tata Mc-Graw Hill.
3. Schildt, H. (2001). *C++: The Complete Reference*. Tata McGraw-Hill.
4. Balagurusamy, E. (2008). *Object Oriented Programming with C++*(6th ed.). Tata McGraw-Hill.
5. Kanetkar, Y. P. (2010). *Let us C++*. BPB Publications.

Suggested E-Resources:

1. The C++ Programming Language by Bjarne Stroustrup
   http://www.stroustrup.com/C++.html
2. Programming in C++
   https://nptel.ac.in/courses/106105151/

CS 425L Object Oriented Methodology and Programming Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Lab Number	**Problems based on**
L1-L2	Operators and Expressions, Conditional and Looping Constructs, Operations on Arrays, Strings Manipulations
L3-L4	Function Components, Default Arguments, Inline Functions, Function Overloading, Functions with Variable Number of Arguments, Recursive Functions
L5-L7	Class Specification, Class Objects, Empty Classes, Passing Objects as Arguments, Returning Objects from Functions
L8-L9	Friend Functions and Friend Classes
L10	Static Data and Member Functions
L11-L12	Constructors, Destructor, Nameless Objects, Copy Constructor, Static Data Members with Constructors and Destructors
L13-L14	Pointers and their Binding, void Pointers, Pointers to Constant Objects, Constant Pointer, Pointers to Objects, Array of Objects, this Pointer
L15-L17	Operator Overloading, Concatenation of Strings, Overloading of new and delete Operators, Data Conversion, Overloading with Friend Functions, Assignment Operator Overloading
L18	Inheritance and Member Accessibility, Constructors and Destructors in Derived Classes
L19-L20	Overloaded Member Functions, Abstract Classes, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Multipath Inheritance and Virtual Base Classes, Hybrid Inheritance
L21	Virtual Functions, Abstract Classes, Dynamic Binding Implementation
L22-L23	Function Templates, Overloaded Function Templates, Multiple Arguments Function Template, User Defined Template Arguments

L24-L25 Class Templates, Inheritance of Class Template

L26 Console I/O, Stream Classes, Unformatted and Formatted I/O Operation, Managing Output with Manipulators

L27-L28 File Handling, File Pointers and their Manipulations, Sequential I/O Operations, Updating a File, Error Handling during File Operation

L29-L30 Exception Handling, Use of Standard Template Library (STL)

MATH 302 Introduction to Discrete Mathematics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Solve counting problems involving the multiplication rule, permutations, and combinations (with and without replacement)
- Have a better understanding of sets, apply the operations of sets and use Venn diagrams to solve applied problems
- Apply the inclusion-exclusion principle to problems with more than two sets and use the principle to solve counting problems
- Understand the basics of discrete probability and be able to apply the methods from these subjects in problem solving
- Demonstrate an understanding of relations and functions and be able to determine their properties
- Understand the basic principles of lattices and Boolean algebra
- Demonstrate an understanding of various types of graph and its properties
- Apply the Pigeonhole Principle to solve various problems
- Understand the numeric function and generating function
- Solve linear homogeneous and linear non-homogeneous recurrence relations with constant coefficients using various methods

Section-A

Permutations, Combinations, selection with & without replacement; Sets and multisets, permutation and combinations of multisets, enumeration of permutations and combination of sets & multisets, placing distinguishable (indistiguishable) objects into distinguishable (indistinguishable) boxes. Inclusion - Exclusion principle, Discrete probability; The rules of sum & product, generation of permutation and combinations. Relations and functions - properties of binary relations, equivalence relations, partial order relations, chains and antichains, Pigeon hole Principle.

Section-B

Basic cancepts of graph theory: vertices, edges, degree, paths, circuits, cycles, complete graphs and trees. Multi-graphs, weighted graphs and directed graphs. Adjacency matrix of a graphs. Connected and disconnected graphs. K-connected and K-edge connected graphs. Shortest path in weighted graphs, Eulerian path and circuits, Hamiltonian path and circuits. Planar graphs, chromatic number, edge colouring of graphs, Vizing's theorem. Trees and cut sets : Trees, spanning tree and cut set, minimum & panning tree.

Section-C

Lattices and boolean algebra; Algebraic structures : binary operation, group, ring, field; Mathematical Logic: Basic connectives, rules of inference, normal forms, proofs of validity, predicate logic. Generating functions and Recurrence relations Linear recurrence relation with constant coefficients and their solution, Homogeneous solution, particular solution & total solutions. Solution by the method of generating functions.

Suggested Books:

1. Liu, C. L. (1987). *Elements of Discrete Mathematics*. Tata McGraw-Hill Education.
2. Kolman, B., Busby, R. C., & Ross, S. C. (2009). *Discrete Mathematical Structures*. PHI Learning.
3. Deo N.(1974). *Graph Theory*, PHI Learning.
4. Trembley J.P. & Manohar R. (1975).*Discrete Mathematical Structures with Applications to Computer Science*. Tata McGraw Hill.

Suggested E-Resources:

1. Discrete Mathematics and Its Applications by Kenneth H. Rosen
   https://mathcs.clarku.edu/~djoyce/ma114/Rosen6E.pdf
2. Discrete Mathematical Structures
   https://nptel.ac.in/courses/106106094/

MGMT 421 Management Information System

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Course Outcomes

On successful completion of the course students will be able to

- Understand the leadership role of Management Information Systems in achieving business competitive advantage through informed decision making.
- Analyze and synthesize business information and systems to facilitate evaluation of strategic alternatives.
- Effectively communicate strategic alternatives to facilitate decision making.
- Describe the role of information technology and information systems in business
- Record the current issues of information technology and relate those issues to the firm
- Reproduce a working knowledge of concepts and terminology related to information technology
- Interpret how to use information technology to solve business problems
- Illustrate the impact of information systems in society

Section-A

Introduction to management, Evolution of management, (Scientific Management – F.W. Taylor, Administration Management – Henry Fayol, Human Relation – Elton Mayo, System Approach) Functions of

management, Overview of contemporary challenges : Global management, Workforce diversity, Corporate, Social responsibility.

Section-B

International Management Information System: Definition and Characteristics, Components of MIS, Framework of understanding MIS: Robert Anthony's, Hierarchy of Management Activity. Information requirements and Levels of Management.

The new strategic role of Information systems, methodologies for evaluating investments in IT, Framework and methodologies should be discussed and illustrated with Case Studies, Critical success factor in implementing IT applications, Study of successful / failed IT projects. Critical role of security in implementing IT application.

Section-C

Decision Support System: Overview, components and classification, steps in constructing a DSS, role in business, group decision support system, integration and implementation of DSS, Information system for strategic advantage, strategic role for information system, reengineering business process, improving business Qualities, Marketing Information system, Manufacturing IS, financial information system.

Suggested Books:

1. Sadagopan, S. (2014). *Management Information Systems* (2nd ed.). PHI Learning, New Delhi.
2. Kroenke, D. M., & Boyle, R. J. (2016). *Using MIS*. PHI Learning, New Delhi
3. Miller, L. (2008). *MIS Cases: Decision Making with Application Software* (3rd ed.). PHl Learning, New Delhi.
5. Robbins, S. P., & Mary Coulter (2010). *MANAGEMENT* (10th ed.). PHI Learning, New Delhi
6. Weihrich, H., & Koontz, H. (2010). *Essentials of Management*(8th ed.). TataMcGraw-Hill.

Third Semester

CS 213 Design and Analysis of Algorithms

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course students will be able to

- Analyze the performance of various algorithms in terms of time and space.
- Solve recurrence relation using various methods
- Describe the concept and design algorithm using data structures including threaded binary tree, B-Tree and hashing techniques.
- Design numerous algorithm techniques including divide & conquer, greedy, dynamic programming, backtracking and branch & bound.

Section A

Analysis of an algorithm. Time and Space complexity. Asymptotic notation to represent complexity of an algorithm. Solving Recurrence relation by substitution method and master theorem

Advanced Data Structures: Threaded Tree, B-Tree, Union and Find operations on Disjoint Set, Hashing and collision resolution techniques,

Section B

Divide and Conquer: General Method.Max-Min, Merge Sort, Quick Sort, and Matrix Multiplication.

Graph: Representation, Breadth First and Depth First Traversals of Graphs, Connected Components.

Greedy Technique: General Method, Knapsack Problem, Job Sequencing with Deadlines, Optimal Merge Patterns, Minimum Cost Spanning Tree (Prim's and Kruskal's Method), Single Source Shortest Path.

Section C

Dynamic Programming: General Method, All Pair Shortest Paths, 0/1 Knapsack Problem, Traveling Salesman Problem.

Backtracking: General Method, N Queen Problem, Sum of Subsets Problem, Graph Coloring Problem, Hamiltonian Cycles, 0/1 Knapsack Problem.

Branch and Bound: General Method, 0/1 Knapsack Problem, Traveling Salesman Problem.

Suggested Books:

1. Horowitz, E., Sahni, S., & Rajsekran S. (2003). Fundamentals of Computer Algorithms. Orient Black Swan.
2. Aho, A. V., Hopcroft J. E., & Ullman J. D. (2016). The Design and Analysis of Computer Algorithms. Addison Wesley.
3. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to algorithms. MIT press.
4. Berlioux, P., & Bizard, P. Algorithms - The Construction, Proof and Analysis of Programs. Wiley.
5. Mehlhorn, K. (2013). Data structures and algorithms Vol. 1 & Vol. 2. Springer Science & Business Media.

Suggested E-Learning Material:

1. Design and Analysis of Algorithms

   https://nptel.ac. in/courses/106101060/

2. Algorithms Specialization

   https://www.coursera.org/specializations/algorithms

3. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to algorithms. MIT press.

   https://mcdtii.files.wordpress.com/2017/03/introduction-to-algorithms-3rd-edition-sep-2010.pdf

CS 213L Design and Analysis of Algorithms Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course students will be able to

- Implement problems based on sorting techniques and max heap.
- Perform various operations on threaded binary tree and B-Tree practically.
- Implement graph based problems.
- Implement problems based on deterministic algorithms.

Lab Number Problems

L-1 L5	Implementation of Max Heap (Creation, Insertion, Sorting), Operations on Sets (Creation, Union. Weighted Union, Find and Collapsing find)
L6-L8	Implementation of Threaded Binary Search Tree (Creation, Insertion, Traversal, Searching, Find successor and predecessor of a given node)
L9-L11	Implementation of Divide and Conquer Algorithms(Merge-Sort, Quick -Sort and Matrix Multiplications)
L 12-L 16	Implementation of Greedy Knapsack problem. Job sequencing with Deadline and Minimum spanning tree algorithms (Prims and Kruskal)
L 17-L20	Implementation of Single source shortest path Algorithms, DFS and BFS Algorithms.
L21-L25	Implementation ofN-Queens, Sum of Subset, Graph Coloring, 0/1 Knapsack Problem and Hamiltonian Cycle

CS 308 Operating Systems

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Learn the fundamentals of Operating Systems.
- Learn the mechanisms of OS to handle processes and threads and their communication
- Learn the mechanisms involved in memory management in contemporary OS
- Gain knowledge on Mutual exclusion algorithms, deadlock detection algorithms and agreement protocols
- Know the components and management aspects of concurrency management
- Learn Case study of Unix OS.

Section-A

Operating system Functions, OS Goals, OS classification: single user, multiuser, Batch Processing Operating System, Time Sharing, Real Time Operating System (RTOS), Multiprogramming Operating System, Multiprocessing System, Networking Operating System,Operating Systems for Embedded Devices, Introduction to popular operating systems like UNIX, DOS, Windows, etc.

Parallel processing and distributed processing: concept, differences, OS.

Process management: Process status, schedulers, scheduling algorithms

Inter process communication: Shared memory and message passing, Process Synchronization, Critical Section problem and its hardware, software and semaphore solutions, classical problems in concurrent programming.

Section-B

Memory management: partition, paging and segmentation demand paging, virtual memory, page replacement algorithms, thrashing.

Secondary storage: Disks, disk space management, Scheduling algorithms. Management file supports, access methods, allocation methods, contiguous,

linked and indexed allocation, directory Systems I/O processor management: I/O traffic controller, I/O scheduler, I/O device handlers.

Section-C

Deadlock: Prevention, Avoidance, Detection and recovery. Protection and Security - Accessibility and Capability Lists UNIX: File System, Inode, Types of shells, Commands (basic, file mgmt, process mgmt, pipelines), vi editor, shell programming.

Suggested Books:

1. Silberschatz, A., Gagne, G., & Galvin, P. B. (2003). *Operating System Concepts* (6th ed.). Addision Wiley Publications.
2. Godbole, A. S. (1995). *Operating Systems with Case Studies in Unix, Netware, Windows NT*. Tata McGraw-Hill Education.
3. Kanetkar, Y. P. (1997). *Unix Shell Programming*. BPB Publications.
4. Tanenbaum, A. S. (2009). *Modern Operating System* (3rd ed.). Pearson Education.
5. Dietel, H. M.(2003).*Operating Systems* (2nd ed.). Pearson Education.

Suggested E-Resources:

1. Operating Systems

https://nptel.ac.in/courses/106108101/

2. Linux for Developers by The Linux Foundation

https://www.coursera.org/learn/linux-for-developers

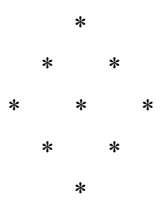
CS 308L Operating Systems Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

UNIX Shell Programming Assignment Lab

1. Shell script to perform various arithmetic operations.
2. Shell script to find the factorial of a number.
3. Shell script to reverse a no. and check for the no. to be palindrome or not.
4. Shell script to find whether no. is prime or not.
5. Shell script to generate Fibonacci series.

6. Shell script to generate table of a given no.
7. Shell script to generate star pattern.



8. Shell script to search a particular login entered by you. This program should continuously run on background to let you know about when that user has logged in.
9. Shell program for sorting a set of nos. The set of no. are to be entered through file.
10. Shell script to Generation and summation of natural numbers (and their various forms) e.g. 12 + 32 + 52 + ...
11. A shell script for binary to decimal conversion.

12-14. Shell program to generate and sum all prime numbers between any two given numbers.

15-17. Shell program for equivalent effect of the DOS command TYPE.

18-20. Shell script to protect a file through password. Password should be displayed in encrypted form.

CS 313 Software Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Understand the system development lifecycle.
- Understand the software-development process, including requirements analysis, design, programming, testing and maintenance.
- Model object-oriented software systems.
- Investigate and improve the specification of a software system.

- Specify, design and construct CASE tools and application software.
- Develop and apply testing strategies for software applications.
- Identify some of the main risks of software development and use.
- Effectively participate in team-based activities.

Section-A

Software engineering concepts, historical perspective, software evaluation, program design paradigms. Software project planning : identifying software scope, resources, Feasibility study, cost/benefit analysis, information gathering, analysis concept, analysis modeling (behavioral model, data model, functional model), Need & Role of System Analyst.

analysis tools & techniques, risk management, project scheduling, tracking. Cost estimation : project metrics, cost factors, cost estimation techniques (decomposition, empirical, automated estimation, delphi)

Section-B

System design : Design concepts & principles (modularization, abstraction, refinement, cohesion, coupling) design methods (structured design, database design, user interface design, object oriented design, real time system design), Implementation : modern programming language features & characteristics, language classes, coding style, efficiency.

Section-C

Software Quality Assurance : Risk management, Quality factors and criteria, SQA metrics, SQA techniques. Verification and Validation : software testing methods (WBT, BBT), software testing strategy (Unit testing, integration testing, validation system, testing), System Implementation/conversion: Direct, parallel, Pilot, phased. Maintenance: Maintenance characteristics, Maintainability, software reuse, re-engineering, reverse engineering, CASE.

Suggested Books:

1. Pressman, R. S. (1997). *Software Engineering: a practitioner's approach* (4th ed.). Tata McGraw-Hill.
2. Jalote, P. (2003).*An Integrated approach to Software Engineering*, Narosa Publications.
3. Awad, E. M., *Systems Analysis and Design*(2nd ed.). Galgotia Publications.
4. Rajaraman, V. *Analysis and Design of Information Systems* (2nd ed.). PHI Learning, New Delhi.

5. Fairley, R.(1997).*Software Engineering Concepts*. Tata McGraw-Hill.
6. Mall, R. (2004). *Fundamentals of Software Engineering*. PHI Learning, New Delhi.
7. Sommerville, I. (2008). *Software Engineering*. Pearson Education.

Suggested E-Resources:

1. Software Engineering

https://nptel.ac.in/courses/106101061/

2. Software Engineering by Roger S. Pressman

http://qiau.ac.ir/teacher/files/911610/13-11-1387-17-31-03.pdf

CS 315 Theory of Computation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Explain basic concepts in formal language theory, grammars, automata theory, computability theory, and complexity theory.
- Understand abstract models of computing, including deterministic (DFA), non-deterministic (NFA), Push Down Automata(PDA) andTuring (TM) machine models and their power to recognize the languages.
- Understand the application of machine models and descriptors to compiler theory and parsing.
- Relate practical problems to languages, automata, computability, and complexity.
- Apply mathematical and formal techniques for solving problems in computer science.
- Understand the relationship among language classes and grammars with the help of Chomsky Hierarchy.

Section-A

Mathematical preliminaries, alphabets, strings, Languages, states, transitions, automata with & without output(Mealy & Moore machine) and

regular expressions, applications e.g. Lexical analyzers and text editors, the pumping Lemma & closure property of regular sets, decision algorithms for regular sets.

Section-B

Context free grammars, Chomsky and Greibach normal form theorems, ambiguity, Pushdown automata and the equivalence of contex free languages to sets accepted by non-deterministic PDA, the Pumping Lemma for CFL's, closure properties of CFL's and decision algorithms for CFL's.

Section-C

Turing Machines: Introduction, Turing hypothesis, Turing computability, nondeterministic, multitape and other versions of Turing machine, Church's hypothesis, primitive recursive function, Godelization, recursively enumerable Languages and Turing Computability. Undecidability: Universal Turing machines and unsolvability of the halting problem, an undecidable problem, Post's Correspondence problem.

Suggested Books:

1. Hopcroft J.E. & Ullman J.D. (2002).*Introduction to Automata Theory, Languages and Computation* (1st ed.). Narosa Publishing House.
2. Mishra, K. L. P., & Chandrasekaran, N. (2006). *Theory of Computer Science: Automata, Languages and Computation*. PHI Learning, New Delhi.
3. Wood, D., (1987). *Theory of Computation* (1st ed.). Harper & Row Publishers, New York.
4. Lewis, H. R., & Papadimitriou, C. H. (2001). *Elements of the Theory of Computation* (1st ed.). Prentice Hall International Inc.

Suggested E-Resources:

1. Theory of Computation
   https://nptel.ac.in/courses/106104028/
2. An Introduction to Formal Languages and Automata by Peter Linz
   http://almuhammadi.com/sultan/books/Linz.5ed.pdf

CS 423 Java Programming

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

On completion of the course students will able to

- Understand concept of Object Oriented Programming & Java Programming Constructs.
- Understand the basic concepts of Java such as Operators, Classes, Objects, Interface, Inheritance, Packages, Enumeration and various keywords.
- Understand the concept of Exception Handling, Collections, Input/output operations, Socket Programming, Database Connectivity.
- Design the applications of Java, Swing, Applet and JSP.
- Analyze & Design the concept of Event Handling and Abstract Window Toolkit (AWT).

Section-A

Java Introduction: Evolution, features, concepts of Java Virtual Machine (JVM) and its task, Java and Internet, Environment (JRE, JDK, JSDK, APIs), Application & Applet, Java Programming: Structure of program, Data Types, Variables, Operators, Expressions, Control statements (sequencing, alteration, looping), Object oriented Concepts, Objects, Classes, Constructors, Method Overloading, Arrays, String handling, Wrapper classes, packages, Access Specifier, Inheritance, Method Overriding, Interfaces, Inner & Anonymous classes

Section-B

Exception handling, Streams and I/O programming, Serialization, Multithreading, Collection framework (Set, Map, List, Vector), Generic, Iterators, Utility Classes (Date, Calender, Random, Timer), Networking, Socket and Datagram Programming.

Section-C

JDBC, ODBC-JDBC Drivers, Types of Drivers, Prepared Statement and Callable Statement, Resultset, Metadata.

Introduction to Web Browser and HTML, GUI in Java, Features of AWT and Swing, Layout Managers, Event handling, Adapter classes, Applets, Java Server Pages: tags and directives.

Suggested Books:

1. Schildt, H. (2007). *Java : The Complete Reference* (7th ed.). Tata McGraw-Hill .
2. Rajagopalan, S., Rajamani, R., Ramesh, K., & Sridhar, V. (2002). *Java Servlet Programming Bible*. Wiley Dreamtech India Pvt. Ltd.
3. Balagurusamy, E. (2007). *Programming with JAVA – A Primer*(3rd ed.). Tata McGraw-Hill.
4. Mughal, K. A., & Rasmussen, R. W. (2009). *A Programmer's Guide to Java SCJP Certification: A Comprehensive Primer* (3rd ed.). Pearson Education.
5. Arnold, K., Gosling, J., & Holmes, D. (2000). *The Java Programming Language* (3rd ed.). Pearson Education.
6. Zukowski, J. (1998). *Mastering Java 2*. BPB Publications
7. Deitel, P.J., & Deitel, H.M. (2009). *Java: How to Program*(7th ed.). Pearson Education.
8. Horstmann, C. S., & Cornell, G. (2005). *Core Java 2 Volume I & II* (7th ed.). Pearson Education.
9. Haecke, B. V. (2000). *JDBC3 Java Database Connectivity*. Wiley Dreamtech India Pvt. Ltd.
10. Bayross, I. (2005). *Web Enabled Commercial Applications Development Using... Java 2* (Revised ed.). BPB Publications.
11. Ganguli, M. (2002). *JSP: A Beginner's Guide*. Wiley Dreamtech India Pvt. Ltd.
12. Liang, Y. D. (2012). *Introduction to Java programming* (9th ed.). Pearson Education.

Suggested E-Resources:

1. Java Lectures

   https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html
2. Object Oriented Programming in Java Specialization by Duke University

https://www.coursera.org/specializations/object-oriented-programming

CS 423L Java Programming Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Lab Number	**Problems**
L1 – L2	Simple Programs
L3 – L4	Programs based on Control Statements
L5 – L8	Programs based on Classes & Inheritance
L9 – L10	Programs based on Arrays
L11 – L12	Programs based on Packages & Interfaces
L13 – L14	Programs based on Wrapper Classes
L15 – L16	Programs based on Exception Handling
L17 – L18	Programs based on I/ O Classes
L19 – L20	Programs based on Strings
L21 – L23	Programs based on Threads
L24 – L26	Programs based on Applets
L27 – L28	Programs based on Graphics
L29 – L32	Programs based on Event Handling
L33 – L35	Programs based on Swings & GUI Components
L36 – L37	Programs based on Serialization
L38 – L39	Programs based on Networking
L40 – L41	Programs based on JDBC
L42 – L45	Programs based on Servlets

TSKL 401 Communication Skills

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**2**	**0**	**0**	**2**

Learning Outcomes:

On completion of the course students will able to

- Understand and apply knowledge of human communication and language processes as they occur across various contexts, e.g., interpersonal, intrapersonal, small group, organizational, media, gender, family, intercultural communication, technologically mediated communication, etc. from multiple perspectives.
- Understand and evaluate key theoretical approaches used in the interdisciplinary field of communication.
- Explain major theoretical frameworks, constructs, and concepts for the study of communication and language, summarize the work of central thinkers associated with particular approaches, and begin to evaluate the strengths and weaknesses of their approaches.
- Understand the research methods associated with the study of human communication, and apply at least one of those approaches to the analysis and evaluation of human communication.
- Find, use, and evaluate primary academic writing associated with the communication discipline.
- Develop knowledge, skills, and judgment around human communication that facilitate their ability to work collaboratively with others. Such skills could include communication Competencies such as managing conflict, understanding small group processes, active listening, appropriate self-disclosure, etc.
- Communicate effectively orally and in writing.

Section-A

Types of Communication- oral communication, written communication- formal, informal, Business letters – types of letter, writing letters, business correspondence, applying for job, Resume writing, filling out employment application.

Language skills: constructing correct sentences by using the right tenses, prepositions, concord. Vocabulary building .

Section-B

Report writing- Defining and determining reports purpose, Report Planning, collecting information, Developing an outline, section of report, types of report, writing short reports, writing long project reports. Writing an abstract for a research paper, dissertation, project report, guidelines for writing a good abstract.Writing a project synopsis-research project synopsis and summer training project synopsis.

Guidelines for writing a good research paper.

Section-C

Introduction to soft skills and hard skills, self development-etiquette and manners, positive attitude and self confidence, motivation skills, communication skills.

Body language: Facial Expression, Posture, Gesture, eye contact, Appearance (Dress Code). Interpersonal Skills: Negotiations, listening skills, social skills, assertive skills, cross-cultural communications.

Goal setting, priority management, time management & career planning. Resume building, Group discussions and Interview skills: Effective interview techniques, mock interviews, stress interviews.

Suggested Books:

1. Raman, M., & Sharma, S. (2004). *Technical Communication: Principles and Practice*. Oxford University Press.
2. Kaul, A., (2009). Business Communication(2nd ed.). PHI Learning.

3. *SOFT SKILLS, 2015, Career Development Centre*, Green Pearl Publications.

4. Tyagi, K., & Misra, P. (2011). *Basic Technical Communication*. PHI Learning.

5. Sharma, S., & Mishra, B. (2009). *Communication Skills: For Engineers and Scientists*. PHI Learning.

6. Flatley, L. (2005). *Basic Business Communication*(10th ed.). Tata McGraw-Hill.

7. Flatley, L. (2008). *Business Communication:Making Connections in a Digital World*(11th ed.). Tata McGraw-Hill.

8. Chaturvedi, P. D., & Chaturvedi, M. (2011). *Business Communication* (2nd ed.). Pearson Education.

9. Covey S. (1998).*Seven Habit of Highly Effective Teens*. New York, Fireside Publishers.

10. Carnegie, D. (1998). *How to Win Friends & Influence People*. New York: Simon & Schuster.

11. Harris, T. A. (1972). *I am OK, You are OK*. New York-Harper and Row.

Suggested E-Resources:

1. English Grammar & Composition BY WREN & MARTIN

   https://www.mockbank.com/bulletin/wp-content/uploads/2016/01/Wren-and-Martin-IRDA-English-Preparation.pdf

Fourth Semester

CS 302 Data Communications and Networks

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

On successful completion of the course students will be able to

- Understand basic computer network technology and the Data Communications System and its components.
- Identify the different types of network topologies, protocols and network devices and their functions within a network.
- Understand the layers of the OSI model and TCP/IP and the function(s) of each layer.
- Understand the importance of data communications and the Internet in supporting business communications and daily activity.
- Design, calculate, and apply subnet masks and addresses to fulfill networking requirements.
- Analyze the features and working of IPV4, IPV6 and their transition with Connection less and Connection oriented Transport layer protocols (TCP/UDP).
- Analyze the features and operations of various protocols such as HTTP, DNS, SMTP and many more application layer protocols.
- Understand and can apply the features of Data Compression, Network and Data security.

Section-A

Data Communication Model, tasks of a communication system, computer network, historical background of computer networks, analog and digital transmission, transmission media, signal encoding techniques: digital data digital signals, digital data analog signals (ASK, PSK, FSK), analog data digital signals (PCM, Delta modulation), analog data analog signals (AM, FM, PM), multiplexing (TDM, WDM, FDM).

Section-B

Principles and Purpose of layered approach, OSI model, TCP\IP protocol suite, Data link control: framing & synchronization, Error detection & Error correction techniques, Flow control & Error Control protocols (stop and wait, sliding window, go-back-N, selective repeat), MAC layer

(CSMA/CD, CSMA/CA), Network switching techniques, Internetworking: various internetworking devices, Routing (unicast routing).

Section-C

Internet Protocols (IPv4, IPv6), IP addressing (classless, classful, IPv6). Transport protocols: TCP, UDP, SCTP; Application layer protocols: DNS, FTP, E-mail, HTTP; Network security: overview of cryptography, RSA algorithm, firewalls.

Suggested Books:

1. Stallings, W. *Data and Computer Communications* (5th ed.). PHI Learning.
2. Forouzan, A. B. *Data Communications & Networking* (4th ed.). Tata McGraw-Hill.
3. Tanenbaum, A. S. *Computer Networks* (3rd ed.). PHI Learning.
4. Kurose, J. F., & Ross, K. W. (2009). *Computer Networking: a Top-Down Approach* (5th ed.). Pearson Education.
5. Gupta, P. C. (2013). *Data Communications and Computer Networks*. PHI Learning.
6. Couch, I. I., & Leon, W. (1998). *Modern Communication Systems: Principles and Applications.* PHI Learning.

Suggested E-Resources:

1. Computer Networking: A Top-Down Approach by James F. Kurose and Keith W. Ross

   https://www.bau.edu.jo/UserPortal/UserProfile/PostsAttach/10617_1870_1.pdf
2. Data Communication

https://nptel.ac.in/courses/106105082/

CS 406 Compiler Design

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Specify and analyze the lexical, syntactic and semantic structures of advanced language features.

- Separate the lexical, syntactic and semantic analysis into meaningful phases for a compiler to undertake language translation.
- Write a scanner, parser, and semantic analyzer without the aid of automatic generators.
- Turn fully processed source code for a novel language into machine code for a novel computer.
- Describe techniques for intermediate code and machine code optimization.
- Design the structures and support required for compiling advanced language features.

Section-A

Analysis of source program, Different phases of a compiler, Symbol Table.

Lexical Analysis : Different approaches to design a lexical analyzer, regular expression, finite automata (Deterministic & Non-deterministic). RE to NFA and NFA to DFA. Optimization of DFA states. Implementation of lexical analyzer (introduction), Context free Grammar.. Errors in different phases of compiler. Introduction to Compiler Construction Tools.

Section-B

Parsing techniques: Top down parsers, Predictive parser

Bottom-up parsers, Shift Reduce parsers, Operator-precedence parsing

LR parsers : SLR, LR(1), LALR

Section-C

Intermediate code generation : Intermediate language, syntax directed translation, assignment statement, Boolean statements and backpatching, array references, procedure calls and record structure.

Code optimization : Principal sources of optimization, Local & Loop optimization, loop invariant computations, induction variable elimination.

Code generation : Design of code generation, a machine model, a simple code generator, register allocation & assignment, code generation from DAG's.

Suggested Books:

1. Aho, U. (1989). *Principles of Compiler Design*. Narosa Publishing House.
2. Aho, Sethi, &Ullman (2007). *Compilers : Principles, Techniques and Tools*. Pearson Education.
3. Louden, K. C. (1997). *Compiler Construction: Theory & Practice*. Cengage Learning.
4. Sorenson, P. G., Tremblay, J. P. (1985). *The Theory and Applications of Compiler Writing*. B. S. Publications Hyderabad.
5. Muchnick, S. S. (1997). *Advanced Compiler Design Implementation*. Morgan Kaufmann.

Suggested E-Resources:

1. Principles of Compiler Design

https://nptel.ac.in/courses/106108113/

2. Compilers by Stanford University

https://web.stanford.edu/class/archive/cs/cs143/cs143.1128/

CS 419 Distributed Computing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Study software components of distributed computing systems. Know about the communication and interconnection architecture of multiple computer systems.
- Recognize the inherent difficulties that arise due to distributed-ness of computing resources.
- Understand the hardware and software concepts of distributed operating systems, various design issues like transparency, flexibility etc., and communication and synchronization in distributed operating systems.
- Understand scheduling in distributed operating systems, fault tolerance, real-time distributed systems, and designing of distributed file systems.

- Understand the concept of design and implementation in the context of distributed operating systems.
- Develop various synchronous and asynchronous algorithms: Leader election, shortest path problem, minimal spanning tress, randomized co-ordinated attack problem, consensus problems and construction of the breath first tree, spanning tree, and maximal independent set.
- Have in-depth knowledge of asynchronous shared memory model including various classical algorithms of mutual exclusion and resource allocation.

Section-A

Distributed Operating System : Distributed Computing system models, Issues in design of distributed operating system, message passing, Remote Procedure Calls, synchronization, process management, resource management, distributed file systems.

Section-B

Distributed Algorithms : Introduction to distributed algorithms, synchronous and partial synchronous models, Algorithms in general synchronous leader election (LCR Algorithm, HS Algorithm, A Simple Flooding Algorithm) , Breadth first search, shortest path, Minimum Spanning Tree, Maximal Independent Set, Distributed consensus with link and process failures. Asynchronous system model, I/O automata, operation of automata, complexity measures, randomizations.

Section-C

Asynchronous shared memory model, mutual exclusion (Dijkstra Mutual Exclusion Algorithm, Lockout-free Mutual Exclusion Algorithm, An algorithm using Single-Writer Shared Register, Bakery Algorithm), resource allocation (Dining Philosophers Problem, Right-Left Dining Philosophers Algorithm, Randomized Dining Philosopher Algorithm), Consensus, Asynchronous network model (Send/Receive Systems, Broadcast Systems, Multicast Systems), basic asynchronous network algorithms, shared memory Vs Networks.

Suggested Books:

1. Sinha, P. K. (2002). *Distributed Operating Systems: Concepts and Design*. PHI Learning.

2. Tanenbaum, A. S. (2009). *Distributed Operating Systems*. Pearson Education .
3. Lynch, N. A. (2009). *Distributed Algorithms* (3rd ed.). Morgan Kaufmann Publications.
4. Rumelhart D.F, McClelland JI & PDP Group (1999).*Parallel Distributed Processing,* vol I&II, MIT Press.
5. Dony, R. D., & Haykin, S. (1999). *Neural Network Approaches to Image Compression* (2nd ed.). IEEE Press.

Suggested E-Resources:

1. Distributed Systems

https://nptel.ac.in/courses/106106168/

2. Distributed Systems by Maarten van Steen

https://www.distributed-systems.net/index.php/books/distributed-systems-3rd-edition-2017/

CS 436 Web Development and .NET Framework

Max. Marks : 60

L	T	P	C
4	0	0	4

Learning Outcomes:

On successful completion of the course students will be able to

- Develop working knowledge of C# programming constructs and the .NET Framework architecture.
- Develop, implement and create Applications with C#.
- Build and debug well-formed Web Forms with ASP. NET Controls
- Perform form validation with validation controls.
- Create custom controls with user controls.
- Use of XML in ADO.NET and SQL server.
- Use ADO.NET in a web application to read, insert, and update data in a database.

Section-A

Introduction to .NET Framework, CLR, MSIL, Metadata, Namespaces, Console Applications using .NET Framework, C# Programming: Introduction, Tokens, Data Types, Variables, Operators, Control Statements, Methods, Arrays, String, Structures, Enumerations, Object Oriented Programming in C#, Classes and Objects, Encapsulation, Polymorphism, Inheritance, Interfaces and Collections, Properties, Exceptions Handling, Garbage Collector, Operator Overload Conversions Operators.

Section-B

Advance C#: Delegates, Events. Advance C# type Construction, Indexers, Generics, Threading, File Handling.

Web Development: Basic Concept of Client-Server Architecture, Elements of Web, Website Design Phases, Characteristics of good Website, HTML, CSS, Client Side and Server Side Coding, Introduction to Scripting Languages (JavaScript, VBScript), Client-Side Validations.

Section-C

Web Application Development using ASP.NET with C#: Web Application in ASP.NET, IIS and Development Server, Migrating ASP Web Application to ASP.NET, Working with HTML Controls, Server Controls, Validation Controls, Working with Classes and Dynamic Link Library (DLL), Master Page, State Management in ASP.NET, Data Binding, Data Management with ADO.NET, Creating & Consuming XML Web Services, Navigation, Localization, Security, Packaging and Deploying ASP.NET Web Application. Introduction to AJAX.

Suggested Books:

1. Schildt, H. (2008). *C# 4.0: The Complete Reference*. Tata McGraw-Hill.
2. Sklar, J. (2010). *Textbook of Web Design*.Publisher Course Technology.
3. Evjen, B., Hanselman, S., & Rader, D. (2008). *Professional ASP. NET 3.5 in C# and VB*. Wrox Publication.
4. *C# 2008 Programming: Covers .NET 3.5 (Black Book)*, Dreamtech Press.
5. Troelsen, A. (2007). *Pro C# With. Net 3.0*. Aprèss Publication, 2007

Suggested E-Resources:

1. W3Schools website

   https://www.w3schools.com/xml/

2. HTML, CSS, and Javascript for Web Developers by Johns Hopkins University

   https://www.coursera.org/learn/html-css-javascript-for-web-developers

3. Internet Technology

   https://nptel.ac.in/courses/106105084/

CS 436L Web Development and .NET Framework Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**8**	**4**

Lab Number	**Problems**
L1-L2	Introduction to Visual Studio .NET
L3-L4	Create, Debug & Run Console Application in C#
L5	Programs based on Control Statements
L6-L8	Programs based on Classes & Inheritance
L9-L10	Programs based on Arrays
L11-L12	Programs based on Enumerations & structures
L13-L14	Programs based on Interfaces & Collection
L15	Programs based on Exception Handling
L16-L17	Programs based on Strings
L18-L19	Programs based on Event Handling
L20-L21	Programs based on Indexers, Operator Overloading, Conversions, Generics
L22-L23	Programs based on ADO.NET
L24	Problems based on HTML forms (GET & POST)
L25-L26	Problem based on ASP

L27	Migrating ASP Web application to ASP.NET
L28-L29	Problem based on HTML Controls
L30-L32	Problem based on Server Controls
L33-L35	Problem based on Validation Server Control
L36-L37	Problem based on Master Page
L38-L39	Problem based on state management in ASP.NET
L40-L41	Problem based on Data Management Using ADO.NET
L42-L44	Problem based on LINQ
L45-L46	Problem based on AJAX
L47-L48	Problem based on packaging & deployment
L49-L50	Introduction to Windows Application & VB.NET
L51	Simple Problems based on Windows Form
L52-L53	Problem based on Different Controls i.e. Boxes, Buttons, Labels, Check Boxes, Radio Buttons, List Boxes, Combo Boxes,, Picture Boxes inVB.NET
L54-L55	Problem based on Scrollbars, Splitters, Timer, Menus, Tree Views, Toolbars, status bars
L56	Problem based on Files I/O
L57-L58	Problem based on Multiple Document Interface (MDI)
L58-L60	Problem based on Dynamic Linked Libraries (DLL)

Fifth Semester

CS 411Computer Graphics

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Gain comprehensive knowledge about the principles and applications of computer graphics.
- Implement various algorithms for scan converting the basic geometrical output primitives, area filling and clipping.
- Design graphics applications such as animations and games etc.
- The student will be able to realistically display 3-Dimensional images on 2-Dimensional plane using projections, shading and illumination models.
- Get the skills to develop the real world graphics applications according to the industry requirements.

Section-A

Components of Graphics Systems: Display devices - Refresh CRTS, Random scan and Raster scan monitors, colour CRT monitors, DVST, Plasma-panel displays, Hard copy devices-printers, plotters. Display processors-random scan systems, DVST systems, Raster scan systems. Interactive Input devices: Keyboards, touch panels, light pens, tablets, joysticks, trackball, mouse. Logical classification - Locator, Stroke, String, Valuator, Choice, Pick devices, Interactive picture construction techniques - positioning methods, constraints, grids, gravity field, rubber band methods, sketching, dragging.

Section-B

Output primitives: Points and lines, DDA and Bresenham's line drawing algorithms. Anti-aliasing lines. Bresenham's circle drawing algorithms. Character generation.

Area filling: Scan line. Boundary-fill, Flood-fill algorithms. 2-D Transformations: Basic Transformations, General Transformation equations. Reflection, Shear. Windowing and clipping: Windowing

concepts, Line, Area, text clipping algorithms. Window to View port Transformation.

Segmentation: Concepts, Segment files, Segment attributes.

Section-C

3D Transformations: 3D co-ordinates. Basic 3D transformations. Rotation about arbitrary axis. Reflection, shear, viewing transformation.

Projections : Perspective Projection-Mathematical Description, Perspective Anomalies, Parallel Projection-Orthographic Projection, Oblique Projection; Cavalier, Cabinet.

Curved lines and Surfaces : Polygon surface, Bezier Curves and surfaces, Spline curves and surfaces.

Fractals Geometry Methods: Introductions.

Hidden surface and Hidden line removal algorithms: Classification of algorithms, Back-face removal, Depth buffer method, Scan line method, Depth sorting method, Area subdivision method. Comparison.

Shading: Constant intensity, Gouraud shading, Phong shading, Ray-tracing algorithms.

Suggested Books:

1. Hearn, D., & Baker, M. P. (1997). *Computer Graphics: C Version* (2nd ed.). Pearson Education.
2. Rogers, D. F., & Adams, J. A. (1990). *Mathematical Elements for Computer Graphics* (2nd ed.). Tata McGraw-Hill.
3. Newman, W. M., & Sproull, R. F. (1997). *Principles of Interactive Computer Graphics*(2nd ed.). Tata McGraw-Hill.
4. Harrington S. (1987).*Computer Graphics:A Programming Approach* (2nd ed.). Tata McGraw-Hill.
5. Foley, J.D., Dam, A. V., Feiner, S.K., &Hughes, J. F. (1996).*Computer Graphics:Principles and Practice* (2nd ed.). Pearson Education.
6. Plastock, R. A.,& Kalley G. (1992).*Theory and Problems of Computer Graphics Schaums Outline Series*. Tata McGraw-Hill.
7. Mukhopadhyay, A., &Chattopadhyay, A. (2007). *Introduction to Computer Graphics and Multimedia* (2nd ed.). Vikas Publishing House Pvt Ltd.

8. Rogers D. F. (1998). *Procedural Elements for Computer Graphics*(2nd ed.). Tata McGraw-Hill.
9. Zhigang, X., Plastock R. (1986).*Schaum's Outlines:Computer Graphics* (2nd ed.). Tata McGraw-Hill.

Suggested E-Resources:

1. Computer Graphics
   https://nptel.ac.in/courses/106106090/
2. Computer Graphics by MIT
   https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-837-computer-graphics-fall-2012/

CS 537L Computer Graphics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**6**	**3**

Lab. No. Program

LI &L2 Implementation of in-built functions ofC-language in Graphics.

L 3 Implementation of Vector Generation Technique and DDA Line Drawing Algorithm.

L 4 Implementation Bresenham's Line Drawing Algorithms.

L 5 Implementation of Simple Circle drawing Algorithm and using Trigonometric method.

L 6 Implementation of the Bresenham's Circle Drawing Algorithm, and Ellipse drawing by modifying Bresenham's Circle drawing algorithm.

L 7 Implementation of the Mid-point Circle Drawing Algorithm.

L 8 Implementation of Line and Point method of polygon drawing.

L 9 Implementation of Inside/Outside test of pixels in respect to a polygon.

L 10 Implementation of the Boundary Fill Algorithm and Flood-Fill Algorithm to fill convex regions.

L I 1 Implementation of Scan Line Conversion Algorithm for Polygon Filling (concave region).

L 12 Problems based on object translations using equations.

L I 3 Problems based on object scaling using equations.

L 14 Problems based on object rotations using equations.

L 15 Problems based on object translations using homogeneous matrices.

L 16 Problems based on object scaling using homogeneous matrices.

L 17 Problems based on object rotations using homogeneous matrices.

L18-L19 Problems based on object reflections using homogeneous matrices.

L 20 Problems based on object shear using homogeneous matrices.

L21-L22 Problems based on composite 2D transformations on any object using homogeneous matrices.

L 23 Implementation ofGupta-Sproull Anti-Aliasing method.

L 24 Problems based on Point Clipping.

L 25 Problems based on Cohen Sutherland Line Clipping Algorithm.

L 26 Problems based on Liang Barsky Line Clipping Algorithm.

L 27 Problems based on Sutherland Hodgeman Polygon Clipping Algorithm.

L 28 Implementation of Hilbert Curve and Koch curve.

L 29 Problems based on Segments.

L 30 Problems based on Character Generation using raster approach.

L 31 Problems based on Simple Parallel Projection.

L 32 Problems based on Simple Perspective Projection.

CS 507 Artificial Intelligence

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Section-A

Introduction to Artificial Intelligence, General problem solving, state space and graph model techniques, Heuristic designs, Aim-oriented heuristic algorithms versus solution guaranteed algorithms, Game playing strategies.

Knowledge Representation : Knowledge representation tools, First order predicate calculus. Understanding Logic Programming Using PROLOG. Semantic Nets, Frames, production rules, knowledge base, the inference system, forward and backward deduction.

Section-B

Cognitive Computing: Introduction, Elements of Cognitive Systems. Understanding Complex Relationships Between Systems. Understanding Cognition. Transformation of Artificial Intelligence into Cognitive Computing Systems. Uses of Cognitive Computing Systems. System of Judgment and Choice. Designing a Cognitive System. Graining Insight from Data. Bringing Data into Cognitive System. Defining Objective. Defining Domain. Understanding the Intended Users and Defining their Attributes. Defining Questions and Exploring Insights. Creating and Refining the Corpora. Training and Testing.Understanding Natural Language, Parsing techniques, context free and transformational grammar, transition net, augmented transition nets, Fillmore's grammar, Shanks conceptual dependency. Grammar free analysers, Sentence generation, Translation.

Section-C

Enabling Reasoning in Cognitive Systems Through Probabilistic Learning: Bayesian Networks, Approximate Inference, Constructing Bayesian Networks. Markov Chains, Hidden Markov Model: Forward Algorithm, Viterbi Algorithm, Baum-Welch Algorithm.Application of Cognitive Computing: Enhancing the Shopping Experience. Leveraging the Connected World of Internet of Things. Voice of the Computer. Fraud Detection. Case Study of Cognitive Computing Systems.

Suggested Books:

1. Russell, S. J., & Norvig, P. (2013). *Artificial Intelligence: A Modern Approach* (3rd ed.). PHI Learning.
2. Vernon, D. (2014). Artificial Cognitive Systems: A Primer. MIT Press.
3. Rich, E., & Knight, K. (2011). *Artificial Intelligence* (3rd ed.). Tata McGraw-Hill.
4. Patterson, D. W. (1990). *Introduction to Artificial Intelligence and Expert Systems*. PHI Learning.
5. Barr, A., Cohen, P. R., & Feigenbaum, E. A. (1982). *The Handbook of Artificial Intelligence*. Addison-Wesley.

6. Allen, J. (1995). *Natural Language Understanding* (2nd ed.). Pearson Education India.
7. Nilsson N.J., (1991).*Principles of Artificial Intelligence*. Narosa Publishing.
8. Nilsson, N. J. (1998). *Artificial intelligence: A New Synthesis*. Morgan Kaufmann Inc.
9. Luger, G. F. (2002). *Artificial intelligence: Structures and Strategies for Complex Problem Solving*. Addison-Wesley.
10. Charniak E.,& McDermott D. (1985).*Introduction to Artificial Intelligence*. Addison-Wesley.

Suggested E-Resources:

1. Artificial Intelligence by IIT Kharagpur

https://nptel.ac.in/courses/106105077/

2. Artificial Intelligence: Principles and Techniques by Stanford University

   https://web.stanford.edu/class/cs221/

CS 508 Big Data Analytics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Understand big data systems and identify the main sources of Big Data in the real world.
- Learn various frameworks like Hadoop, NOSQL to efficiently store retrieve and process Big Data for Analytics.
- Implement several Data Intensive tasks using the Map Reduce Paradigm in Hadoop.
- Program applications using tools like Hive, pig, NO SQL for Big data Applications.
- Construct scalable algorithms for large Datasets using Map Reduce techniques.

- Apply the knowledge of Big Data gained to fully develop BDA applications for real life applications.

Section-A

Introduction to Big Data, Evolution, Structuring Big Data, Types of Big Data, 4 Vs, Big Data Analytics: Advantages, Applications. Comparing Report and Analysis. The Analytic Process, Types of Analytics. Characteristic of Big Data Analytics. Framing the Problem for Analytics. Statistical Significance or Business Importance of Analytics. Making Inferences. Analytic Approaches: History and Ensemble Methods, Graphical User Interface, Point Solutions, Data Visualization for Big Data.

Section-B

Gathering Data on a Distributed Environment. Architecture and Features of Hadoop Framework: HDFS, Map Reduce, YARN, Hbase, Hive, Sqoop, Zookeepker, Oozie. Exporting Data to HDFS and Importing Data from HDFS, HDFS Commands. HBase Architecture, Storing Big Data with Hbase, Interacting with Hadoop Ecosystem, Combining HBase and HDFS.

MapReduce Framework, Working of Map Reduce, Techniques to Optimize MapReduce Jobs. Building and Executing Applications. Controlling Map Reduce Execution with Input Format, Taking Input from files and applying operations for customization.

Section-C

Understanding Hive, Hive Variables, Properties, Queries and Data Types. Built in Functions in Hive. Working with Databases in Hive: Creating, Viewing, Droping and Altering. Creating and Modifying Tables. Using Hive DDL Statements and DML Statements. Executing HiveQL. Applying Joins, Group By and Order By clauses.

Pig Architecture. Properties of Pig, Running Pig Programs, Working with Operators in Pig, Working with Functions in Pig.

Suggested Books:

1. White, T. (2012). *Hadoop: The Definitive Guide*. O'Reilly Media, Inc.
2. Miner, D., & Shook, A. (2012). *Map Reduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems*. O'Reilly Media, Inc.

3. Loshin, D. (2013). *Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph*. Elsevier.

Suggested E-Resources:

1. Big Data & Analytics by Kent State University
   http://www.cs.kent.edu/~jin/BigData/index.html
2. Big Data Specialization by University of California San Diego
   https://www.coursera.org/specializations/big-data

CS 536L Big Data Analytics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**6**	**3**

Lab. No.	**Program**
L1-L2	Basic Linux command for listing, making and changing the directories and files.
L3-L4	Linux file system security command: access rights and changing access rights.
L5-L6	Linux file system command for processes and jobs.
L7	Demonstrate the look and feel of cloudera and hadoop ecosysytem.
L8	Demonstrate the various demons of hadoop file system.
L9-L10	HDFS commands.
L11	Import and export the input and output files from local file system to HDFS and vice versa.
L12	Sharing the files and directories from Windows to Cloudera.
L13-L16	Compilation and Execution of MapReduce programming example in HDFS environment.
L17-L18	Working with database in apache Hive: creating, Viewing, Dropping and Altering.

L19-L22 Working with Apache Hive Operators, Functions and Join operation.

L23-L24 Apache Hive DDL and DML commands.

L25 HiveQL: Group BY and Order By clauses.

L26-30 Working with Apache PIG Latin Operators and Functions.

*In Hadoop

Discipline Elective - I & II

CS 427 Parallel Computing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

CS 427 Parallel Computing

Learning Outcomes:

On successful completion of the course students will be able to

- Develop computer program for different type of parallel computers.
- Measure the performance of algorithm used and parallel computers.
- Solve problem using parallel computers.
- Optimize sequential code to parallel code and determine if they are worthwhile to parallelize. Develop, analyze and implement algorithm for parallel computers with shared memory and with distributed memory.
- Analyze and perform development work related to use of parallel computers and are able to get placement in the govt. organization.

Section-A

Introduction to parallel computing, advantages of parallel computing. Solving problems in parallel : Temporal parallelism, Data parallelism and their comparison. Intertask dependency and task graphs. Structures of parallel computers : Pipelined paprallel computers, Array processors, Shared memory multi-processor, message passing multiprocesors, MMC

systems. Integer Arithmetic : Carry look-ahead addition and carry-save addition on binary tree, integer multiplication and convolution on a linear array. Elementary sorting algorithm.

Section-B

Matrix Algorithms : Matrix-Vector multiplication and solving lower triangular system of equations on a linear array, matrix multiplication, LU decomposition, matrix inversion, Guassian elimination on a mesh.

Graph Algorithms : Mesh algorithm for tranisitive closure, connected component, shortest path, breadth first search and minimum spanning tree. Mesh of trees and its applications such as Matrix-Vector multiplication, Convolution and integer multiplication.

Section-C

More fancier networks : r-dimensional mesh of trees, shuffle trees, shuffle-exchange network, hypercube, De-bruijn network and butterfly. Some examples on these networks, sorting and FFT on butterfly.

Introduction to dataflow computers. Parallelism in logic programming.

Programming parallel computers.

Suggested Books:

1. Rajaraman, V. (1990). *Elements of Parallel Processing*. PHI Learning.
2. Quinn, M. J. (1978). *Designing Efficient Algorithms for Parallel Computers*. Tata McGraw-Hill.
3. Lakshmivaraha, S., & Dhall, S. K. (1990). *Analysis and Design of Parallel Algorithms: Arithmetic and Matrix Problems*. Tata McGraw-Hill, Inc.

Suggested E-Resources:

1. Parallel Computing

https://nptel.ac.in/courses/106102114/

CS 431 Real Time Systems

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Explain fundamental principles for programming of real time systems with time and resource limitations.
- Describe the foundation for programming languages developed for real time programming.
- Account for how real time operating systems are designed and functions.
- Describe what a real time network is.
- Use real time system programming languages and real time operating systems for real time applications.
- Analyze real time systems with regard to keeping time and resource restrictions.

Section-A

Introduction to Real-time computing: Characterizing Real-time system & tasks; Performance measures of real time systems, estimation of program run time, Real-time system design: Hardware requirement, system-development cycle, data transfer techniques, synchronous & asynchronous data communication, standard interfaces.

Section-B

Task Assignment and Scheduling: Priority scheduling, scheduling with fixed priority dynamic priority scheduling, Real-time programming languages & Tool: desired language characteristics, data typing, control structure, run time error handling, overloading & generics, run time support, Real-time databases.

Section-C

Real time communication algorithms, Fault tolerence techniques: Causes of failure, fault types, fault detection, redundancy, integrated failure handling Reliability Evaluation techniques: Parameter values, reliability model for hardware redundancy, software error model, Clock synchronization.

Suggested Books:

1. Krishna, C.M., & Shen, K.G. (1997).*Real Time Systems*.Tata McGraw-Hill.
2. Liu Jane W.S. (2000).*Real Time Systems*, Pearson Education.
3. Laplante, P. A. (1997). *Real Time Systems Design Analysis* (2nd ed.). PHI Learning.

Suggested E-Resources:

1. Real-Time Systems by Jan Jonsson

   http://www.cse.chalmers.se/edu/year/2015/course/EDA222_Real_Time_Systems/Documents/Slides/
2. Fault Tolerance by Yandex

   https://www.coursera.org/lecture/big-data-essentials/fault-tolerance-rcwk5

CS 433 Soft Computing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Develop NN network based application.
- Differentiate between supervised, unsupervised and reinforcement learning.
- Apply fuzzy logic on real life problems.
- Design Hybrid Systems vizNeuro-Fuzzy, Neuro- Genetic, Fuzzy-Genetic systems.

Section-A

Neural Network(NN) Paradigms : Introduction, Neuron model, Neural network architectures, Learning Rules (Hebbian, Competitive, Baltzmann, Supervised, unsupervised) Types of neural networks : Perceptron, MLP, radial basis function network, recurrent network, self organizing Feature maps, Boltzamann m/c, Applications of NN.

Section-B

Fuzzy Logic : Introduction, Fuzzy sets, Basic operations on fuzzy sets, relations, rule based models and linguistic variables, fuzzy control, interpolation in fuzzy rule base, Applications of Fuzzy logic.

Section-C

Evolutionary Computations : Introduction, Genetic Algorithm(GA), Evolutionary programming, Classifier systems, genetic programming parse trees, Mathematical foundation of GA variants of GA (hybrid GA, Fuzzy GA Enhancements of genetic programming, application).

Suggested Books:

1. Haykin, S. (2009). *Neural Networks: A Comprehensive Foundation*. Pearson Education.
2. Klir, G. J., & Yuan, B. (2010). *Fuzzy Sets and Fuzzy Logic: Theory and Applications*. PHI Learning.
3. Goldberg, D. E. (2007). *Genetic Algorithms in Search Optimization and Machine Learning.* Pearson Education.
4. Jang, J. S. R. (2003). *Neuro-Fuzzy and Soft Computing; A Computational Approach to Learning and Machine Intelligence*. PHI Learning.
5. Freeman, J. A. (2002). *Algorithms, Applications, and Programming Techniques*. Pearson Education.
6. Bart, K. (2003). *Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence*. PHI Learning.
7. Li, H. (1995). *Fuzzy Logic and Intelligent Systems*. Kluwer Academic.
8. Zimmermann, H. J. (1996). *Fuzzy Set Theory and Applications*. Allied Publishers.
9. Driankov, D. (1996). *An Introduction to Fuzzy Control*. Narosa.
10. Mitchell, M. (1996). *An Introduction to Genetic Algorithms*. PHI Learning.

11. Rajasekaran, S.,& Pai, G. V. (2003). Neural Networks, Fuzzy Logic and *Genetic Algorithms: Synthesis and Applications*. PHI Learning.

12. Yegnanarayana, B. (2003). *Artificial Neural Networks*. PHI Learning.

Suggested E-Resources:

1. Neuro-Fuzzy and Soft Computing by University of Southampton

http://www.cs.nthu.edu.tw/~jang/nfsc.htm

2. Introduction to Soft Computing

https://nptel.ac.in/courses/106105173/

3. Neural Networks and Deep Learning by Andrew Ng

https://www.coursera.org/courses?query=neural%20networks

CS 511 Cloud Computing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Apply cloud computing model in real application.
- Use programming paradigms like MapReduce to create applications.
- Operate cloud by installing virtual machines and apply migration.
- Understand the challenges of cloud
- Aware about the Access Control mechanisms of cloud.

Section-A

Cloud Computing Fundamentals: Definition, Characteristics, Evolution, Architecture, deployment models and service models, Cloud Computing Stack, Applications, Benefits, and Limitation.

Web Technologies for Cloud: Service Oriented Architecture, Web 2.0, Web services, Data Format (XML, JSON).

Virtualization Technology: Overview, Architecture, Virtual machine technology, Virtual Machine Provisioning & Migration, Fault Tolerance Mechanisms. virtualization of data centers.

Section-B

Resource Management and Load Balancing: Distributed Management of Virtual Infrastructures, Server consolidation, Dynamic provisioning and resource management, Resource Optimization, Resource dynamic reconfiguration, Scheduling Techniques for Advance Reservation, Capacity Management to meet SLA Requirements, and Load Balancing, various load balancing techniques.

Interoperability: Issues with interoperability, Federated clouds, Cloud federation stack, Interoperability approaches.

Implementation: Study of Cloud computing Systems like Amazon EC2 and S3, Google App Engine, and Microsoft Azure, Build Private/Hybrid Cloud using open source tools (OpenStack**, Docker).**

Section-C

Data In Cloud: Characterizing data-intensive computations, Technologies for data-intensive computing, Cloud file systems:GFS And HDFS, NoSQL systems: Big Table, HBase, Programming platforms: Map-Reduce.

Cloud Security: Vulnerability Issues and Security Threats, Application-level, Security, Data level Security, and Virtual Machine level Security, Infrastructure Security, and Multi-tenancy Issues.

Advances: Energy efficiency in clouds, Green Computing, Fog Computing, Mobile Cloud Computing, Cloud Standards.

Suggested Books:

1. Krutz, R. L., & Vines, R. D. (2010). *Cloud Security: A Comprehensive Guide to Secure Cloud Computing*. Wiley Publication.
2. Shroff, G. (2010). *Enterprise Cloud Computing: Technology, Architecture, Applications*. Cambridge University Press.
3. Mather, T., Kumaraswamy, S., & Latif, S. (2009). *Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance*. O'Reilly Media, Inc.

4. Velte, A. T., Velte, T. J., Elsenpeter, R. C., & Elsenpeter, R. C. (2010). *Cloud Computing: A Practical Approach*. Tata McGraw-Hill.
5. Saurabh K. (2011). *Cloud Computing* (1st ed.). WILEY India Pvt. Ltd.
6. Sosinsky, B. (2011). *Cloud Computing*. WILEY India Pvt. Ltd.
7. Ferretti, S., Ghini, V., Panzieri, F., Pellegrini, M., & Turrini, E. (2010). *QoS–Aware Clouds*. IEEE 3rd International Conference on Cloud Computing.

Suggested E-Resources:

1. Cloud Computing
   https://nptel.ac.in/courses/106105167/1
2. Cloud Computing Specialization
   https://www.coursera.org/specializations/cloud-computing

CS 519 Data Warehouse and Data Mining

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Identify the scope and necessity of Data Mining & Warehousing for the society.
- Describe the designing of Data Warehousing so that it can be able to solve the root problems.
- Understand various tools of Data Mining and their techniques to solve the real time problems.
- Develop ability to design various algorithms based on data mining tools.
- Develop further interest in research and design of new Data Mining techniques.

Section- A

Introduction to Business Intelligence, Decision support system, Knowledge discovery & decision making, need for data warehouse, definitions of Data warehousing and data mining, common characteristics of Data warehouse, Data Marts, Metadata, Operational versus analytical databases, trends and

planning of Data warehousing, Defining business requirements, Data Warehouse Architecture, Data modeling strategy, Fact tables, dimensions, Star schema and other schemas, Multi dimensional data models, Data Cube presentation of fact tables, using the Data warehouse, OLAP models and operations, Implementation of Data warehouse

Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, issues in Data Mining, Data Preprocessing: Needs Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation

Section- B

Data Mining Primitives, Languages, and System Architectures: Data Mining Primitives, Data Mining Query Languages, Architectures of Data Mining Systems, Concepts Description: Characterization and Comparison: Data Generalization and Summarization-Based Characterization, Analytical Characterization: Analysis of Attribute Relevance, Mining Class Comparisons: Discriminating between Different Classes, Mining Association Rules in Large Databases: Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases(Apriori,FP-tree), Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules

Section -C

Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Classification by Back propagation, Classification Based on Concepts from Association Rule Mining, Prediction, Classifier Accuracy, Cluster Analysis, Types of Data in Cluster Analysis, Major Clustering Methods (K means, Hierarchal clustering, DBSCAN), Mining Complex Types of Data: Multidimensional Analysis and Descriptive Mining of Complex, Spatial Mining, Multimedia Mining ,Time-Series and Sequence Data, Mining, Text Mining, Web Mining, Trends in Data Mining, Introduction to Various Data mining tools(SAS Enterprise Miner 5.1, Oracle Data Mining, SPSS Clementine 8.5)

Suggested Books:

1. Kimball, R., Ross, M. (2008). *The Data Warehouse Lifecycle Toolkit* (2nd ed.). John Wiley & Sons.

2. Han, J., Kamber, M. (2011*). Data Mining: Concepts and Techniques* (2nd ed.). Elsevier.
3. Inmon, W. H. (2005). *Building the Data Warehouse* (4th ed.). John Wiley & sons.
4. Anahory, S., & Murray, D. (1997). *Data Warehousing in the Real World: A Practical Guide for Building Decision Support Systems*. Pearson Education.

Suggested E-Books:

1. Data Mining
   https://nptel.ac.in/courses/106105174/
2. Business intelligence and data warehousing by Universidad Nacional Autónoma de México
   https://www.coursera.org/learn/business-intelligence-data-warehousing

CS 527 Mobile Computing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Have knowledge of fundamentalsof mobile communication systems.
- Choose system (TDMA/FDMA/CDMA) according to the complexity, installation cost, speed of transmission, channel properties etc.
- Identify the requirements of mobile communication as compared to static communication.
- Identify the limitations of 2G and 2.5G wireless mobile communication and use design of 3G and beyond mobile communication systems.

Section A

Introduction to Wireless Communication System : Evolution, Generations (1G, 2G, 2.5G, 3G), Wireless Transmission : Frequencies, ISM, Signals, Antennas; Signal propagation effects; Comparison of Wireless Communication Systems : Land-Mobile technologies (GSM, CDMA),

Satellite Communication, In building Communication Systems, Personal Communication Systems.

Cellular Concept : Basics & Traffic concepts, System Capacity, Trunking theory & GoS, Improving coverage & capacity - Frequency reuse. Cell Splitting/Sectoring, Umbrella cell, Breathing cell

Section B

Wireless MAC protocols : S/F/T/CDMA, CSMA protocols, MACAW, Spread Spectrum : DSSS, FHSS; WWAN (GSM : Mobile services, System Architecture, Radio Interface, Protocols, Localization & Calling, Handover, Security, New Data Services; CDMA); WLAN (IEEE 802.11 : System architecture, Protocol architecture, MAC Management; H1PERLAN : Introduction), Mobile IP, MANET : Routing protocols, DHCP, Unicast & Multicast Communication; Wireless TCP; WPAN : Blue tooth, IEEE 802.15 (Introduction)

Section C

Mobile Computing: Challenges, Issues; Location & Data Management; Power management, Power-aware & Context-aware computing, Support for Mobility : WAP

Introduction to Pervasive Computing - Applications, Devices, Software; Mobile Computing Software development : Strategies & Tools

Suggested Books:

1. Schiller, J. H. *Mobile Communications* (2nd ed.). Pearson Education.
2. Stojmenovic, I. (2003). *Handbook of Wireless Networks and Mobile Computing*. John Wiley & Sons.
3. Rappaport, T. S. *Wireless Communications: Principles and Practice* (2nd ed.). PHI Learning.
4. Williams, V. *Wireless Computing Primer*. M & T Books.
5. Pandya, R. (1994). *Mobile and Personal Communication Systems and Services*. PHI Learning.
6. Hansmann, U., Merk, L., Nicklous, & M.S., Stober. *Pervasive Computing HandBook*. Springer.
7. Perkins, C. E., Alpert, S. R., & Woolf, B. (1998). *Mobile IP: Design Principles and Practices*. PHI Learning.

8. Garg, V. K. & Wilkis, J. E. (1996). *Wireless and Personal Communication*. PHI Learning.
9. Muller, N. J. (2001). *Bluetooth Demystified*. Tata McGraw-Hill.
10. Sturman, C. F., & Bray, J. *Bluetooth: Connect without Cables* (2nd ed.). Pearson Education.
11. Dhawan, C. (1997). Mobile Computing: A Systems Integrator's Handbook. Tata Mc-Graw-Hill

Suggested E-Resources:

1. Wireless Communications by Stanford University
   https://web.stanford.edu/class/ee359/
2. Data Communications II by University of Massachusetts Lowell
   http://mobile.cs.uml.edu/~glchen/cs414-564/handouts/

CS 528 Modeling and Simulation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Define basic concepts in modeling and simulation (M&S).
- Classify various simulation models and give practical examples for each category.
- Construct a model for a given set of data and perform its validity.
- Generate and test random number and apply them to develop simulation models.
- Analyze output data produced by a model and test validity of the model.
- Explain parallel and distributed simulation methods.
- Know how to simulate any discrete system using queuing systems.

Section-A

Definition of system, system concepts, types of system. Continuous & discrete system, Models :- compartmental model, Iinear and nonlinear model, stochastic model, Verification & validation

Simulation: Introduction, classification of simulation models. Advantages & disadvantages of simulation. Discrete system simulation: Monte Carlo

method, random no. generation, test of randomness, Probability Distributions and their random variates.

Section-B

Introduction to queuing theory: Queuing model with poison input, Exponential service & arbitrary service times, Simulation of queuing system, Simulation of single server queue; Simulation of two server queue, Application of queuing theory in computer system like operating system, computer network etc.

Introduction to inventory theory, EOQ Models, More complex inventory models.

Section-C

[Introduction of Simulation of system dynamics model]

Evaluation of simulation, length of simulation runs, Introduction to Variance reduction techniques.

Project management: Simulation of Pert /CPM technique

Models as component of information system *Modeling for decision support Virtual reality: ultimate interactive model*. [Simulation languages :- Simula. Dyanamo, Stella]

Simulation language:- Simula (Basic facts, History of Simula I and 67, Data types, Statements, Procedure, Classes and Packages)

Suggested Books:

1. Gordon, G. *System Simulation*. PHI Learning.
2. Deo, N.*System Simulation*. Tata Mcgraw-Hill.
3. Payne, J.A. *Introduction to Simulation.*Tata McGraw-Hill.
4. Law, A.M., Kelton W.D. *Simulation Modelling and Analysis*. Tata McGraw-Hill

Suggested E-Resources:

1. Modelling and Simulation of Descrete Event System
   https://nptel.ac.in/courses/112107220/
2. Simulation and modeling of natural processes by University of Geneva
   https://www.coursera.org/lecture/modeling-simulation-natural-processes/modeling-and-simulation-F7vas

CS 529 Natural Language Processing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Develop algorithms based on NLP Concepts.
- Develop applications based on Statistical Approaches of NLP.
- Create applications for Indian Language Processing.

Section-A

Introduction to Natural Language Understanding, Language as a knowledge base process, Processing Indian Languages, Basic linguistics.

Morphology - Types and Parsing, N-gram Model, Maximum Likelihood Estimation, Smoothing techniques on N-gram Model, Words and Word Classes, POS Tagging.

Grammar and Parsing - Top Down Parsing, Bottom-up Parsing, Dependency Grammar, Parsing Indian Languages.

Section-B

Meaning Representation, First Order Predicate Calculus, Elements of FOPC, Semantics and FOPC, Syntax Driven Semantic Analysis, Principle of Compositionally, Semantic Augmentation of CFG Rules, Robust Semantic Analysis, Introduction to Semantic Grammar, Structure of Words, Thematic Roles, Word Sense Disambiguation - Selectional Restrictions, Machine Learning Approaches, Dictionary Based Approaches

Section-C

Context and World Knowledge, Knowledge Representation and Reasoning, Discourse and World Knowledge, Cohesion, Reference Resolution, Various Resolution Algorithms, Discourse Coherence, Coherence Relations, Language Learning.

Suggested Books:

1. Jurafsky, D., & Martin, J. H. (2000). *Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*. Pearson Education.
2. Allen, J. (1995). *Natural Language Understanding* (2nd ed.). Pearson Education.

3. Bharati, A., Chaitanya, V., Sangal, R., & Ramakrishnamacharyulu, K. V. (1995*). Natural language Processing: a Paninian Perspective*. PHI Learning.
4. Manning, C. D., Manning, C. D., & Schütze, H. (1999). *Foundations of Statistical Natural Language Processing*. MIT press.
5. Iwanska, L. M.,Shapiro, S. C. (2001).*Natural Language Processing and Knowledge Representation*.Universities Press.

Suggested E-Resources:

1. Natural Language Processing by National Research University Higher School of Economics
   https://www.coursera.org/learn/language-processing
2. Natural Language Processing
   https://nptel.ac.in/courses/106101007/

CS 601 Cyber Security

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Evaluate the computer network and information security needs of an organization.
- Assess cyber security risk management policies in order to adequately protect an organization's critical information and assets.
- Measure the performance of security systems within an enterprise-level information system.
- Troubleshoot, maintain and update an enterprise-level information security system.
- Implement continuous network monitoring and provide real-time security solutions.
- Formulate, update and communicate short- and long-term organizational cyber security strategies and policies.

Section-A

Information Security Concepts: Introduction to Cyber security, Cyber security: objectives, roles.

Differences between Information Security & Cyber security. Cyber security Principles: The CIA triad (Confidentiality, integrity,& availability Authentication & non-repudiation.

Section-B

Security Threats and vulnerabilities : Overview of Security threats ,Risks & Vulnerabilities, Basics of risk management. Hacking Techniques, Password Cracking , Trends in the Types of Attacks and Malware.

Hash and Authentication:Authentication Overview, Hash Functions, The Properties of Hash Functions, Feasible Attacks to a Hash. Online Authentication: The One-Time Password and Token, Two-Factor Authentication, The OTP Standards.

Section-C

Defensive measures for cyber security: The Overview of Firewalls, Types of Firewalls, challenges.

The intrusion detection system (IDS) and the intrusion prevention system (IPS), Digital Signature.

Cyberspace and the Law: Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013.

Suggested Books:

1. Wu, C. H. J., & Irwin, J. D. (2016). *Introduction to Computer Networks and Cybersecurity*. CRC Press.
2. Dowd, M., McDonald, J., & Schuh, J. (2006). *The Art of Software Security Assessment: Identifying and Preventing Software Vulnerabilities* (1st ed.). Addison-Wesley Professional.
3. Graham, J., Olson, R., & Howard, R. (2016). *Cyber Security Essentials*. CRC Press, Taylor and Francis.

Suggested E-Resources:

1. Cyber Security by courser website:

   https://www.coursera.org/learn/cyber-security-domain

2. Ahmad Kamal, The law of Cyber-Space an Invitation To The Table of Negotiations, UNITAR United Nations Institute of Training and Research, October 2005.

3. CYBER LAW - An exhaustive section wise Commentary on The Information Technology Act along with Rules, Regulations, Polices, Notifications etc. by Pavan Duggal

CS 602 Digital Image Processing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Explain how digital images are represented and manipulated in a computer, including reading and writing from storage, and displaying. Write a program which implements fundamental image processing algorithms.
- Conversant with the mathematical description of image processing techniques
- Know how to go from the equations to code.

Section-A

Image processing: introduction, linear systems, the Fourier transforms, matrix theory results.Image Perception: Light, Luminance, Brightness, Contrast, MTF of Visual System, Visibility Function, Monochrome Vision Models and Color Vision Models, Temporal properties of vision.Image Sampling: 2-D sampling theory, Nyquist theorem.Image Quantization: Optimum Mean Square (Lloyd-Max) Quantizer, Compandor design.

Section-B

Image transforms: two dimensional orthogonal and unitary transforms, properties, one dimensional discrete Fourier transform (DFT), two dimensional DFT, Cosine transform, Sine transform.Image enhancement: point operation, histogram modelling, spatial operations, transform operation, multispectral image enhancement, false color and pseudocolor, color image enhancement. Image filtering and restoration: image observation models, Inverse and Wiener filtering, finite impulse response (FIR) wiener filtering, other Fourier domain filters.

Section-C

Image Analysis: Feature extraction, Edge detection, Scene segmentation and labelling.Pattern recognition: Introduction, Recognition process, Statistical decision making (Bayes' theorem), Nonparametric decision making (Nearest neighbourhood classification techniques), Clustering.

Suggested Books:

1. Jain A. K. (1989).*Fundamentals of Digital Image Processing*. PHI Learning.
2. Gonzalez, R. C., & Woods, R. E. (2008). *Digital Image Processing* (3rd ed.). Pearson Education.
3. Jayaraman S., Esakkirajan S., &Veerakumar T. (2009).*Digital Image Processing*. Tata McGraw-Hill.
4. Rosenfield, A., Kak A. C (1982).*Picture Processing*. NY: Academic Press.
5. Pratt, W. K. (1991). *Digital Image Processing* (2nd ed.). John Willey and Sons.
6. Duda R., Hart Peter, Stork D. (1973).*Pattern Classification*. Willey Interscience Publication.
7. Friedman, M., & Kandel, A. (1999). *Introduction to Pattern Recognition: Statistical, Structural, Neural and Fuzzy Logic Approaches*. World Scientific Publishing Company.

Suggested E-Resources:

1. Digital Image Processing by Stanford University

https://web.stanford.edu/class/ee368/

2. Digital Image Processing

https://nptel.ac.in/courses/117105079/

ELE 304 Digital Signal Processing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to

- Describe the characteristics and transformations of discrete time signals mathematically.
- Apply techniques in time and transform domains to the analysis and design of discrete-time systems
- Estimate the spectra of deterministic and stochastic signals, and appropriately interpret the information contained therein
- Demonstrate the ability to manipulate signals using analytical techniques and write algorithms to implement discrete-time systems
- Describe the techniques for signal modulation and discriminate between the different modulation schemes used in communication systems

Section-A

Introduction of Signals, Systems and Signal Processing, Classification of Signals and Systems, Advantages of Digital over Analog Singnal processing, Signal Models - Continuous Time versus Discrete time signals, Periodic and Aperiodic Signals, Phasor Signals and Spectra, Energy and Power Signals, System Modeling Concepts, The superposition integral for Fixed and Linear Systems, Impulse Response of a Fixed and Linear System - Fourier Series - Trigonometric Series-

Exponential Fourier Series-Symmetry Properties of the Fourier Coefficients.

Fourier Integral, Energy Spectral Density, Fourier Transforms in the Limit, Fourier Transform Theorems and Pairs, System Analysis with Fourier Transform, Laplace Transform Theorems, Network Analysis using the Laplace Transform.

Section-B

Discrete Time Signals and Systems - Review of Sampled Data Systems, Time Domain Representations of Discrete Time Signals, Frequency Domain Representation of Discrete Time Signals, Discrete Time Signals obtained by sampling, Discrete Fourier Transform. Z-Transform - Definition and Examples, Inverse Z-Transform, Properties of the Z-Transform, Introduction to Realization of Digital Systems - Block Diagrams and Signal Flow Graphs. Introduction to Realization of an IIR and FIR systems, Discrete Fourier Transforms (DFT) and Fast Fourier Transform (FFT).

Section-C

Design of Digital Filters : Introduction to Filters, A comparision of IIR and FIR Digital Filters. Design of IIR Digital Filters - Impulse Invariant Transformation, Bilinear Transformation, Design of Digital Butterworth and Chebyshev Filters.Design of FIR Digital Filters - Windowing and Rectangular Window, Filter Designs using Windows, Frequency Sampling Technique. DSP tools and DSP techniques in various applications.

Suggested Readings:

1. Proakis J.G.,&Manolakis D.G. *Digital Signal Processing: Principles, Algorithms and Applications*(3rd ed.). PHI Learning.
2. Oppenheim, A. V., & Schafer, R. W. *Digital Signal Processing*. PHI Learning.
3. Nagarath, I.J., Sharan S.N., Ranjan R., & Kumar S. *Signals and Systems*.Tata McGraw-Hill.
4. Mitra, S.K. (2010). *Digital Signal Processing : A Computer Based Approach* (2nd ed.). Tata McGraw-Hill.

5. Defatta J.*Digital Signal Processing*. John Willey & Sons.

Suggested E-Resources:

1. Digital Image Processing by Stanford University

https://web.stanford.edu/class/ee368/

2. Digital Image Processing

https://nptel.ac.in/courses/117105079/

IT 506 Human Computer Interaction

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

On successful completion of the course students will be able to

- Develop effective UI.
- Design menus using STM.
- Develop applications based on cognitive architecture

Section - A

Introduction to Human Computer Interaction: Need and advantages.

Humans in HCI: Input-output channels; human memory; Reasoning and problem solving; emotional and psychological issues.

Computers in HCI: Text entry devices; positioning, pointing and drawing; display devices; devices for virtual reality and 3D interaction; physical controls; printing and scanning; memory; processing and networks.

Interaction Issues: Models of interaction; frameworks and HCI; Ergonomics; interaction styles; elements of WIMP interface; interactivity and the context of the interaction.

Section - B

Interaction Design Basics: Introduction to design; the process of design; user focus and scenarios; navigation design; screen design and layout; iteration and prototyping.

HCI in the Software Process: Usability engineering; iterative design and prototyping; design rationale.

Design Rules: Principles to support usability; standards and guidelines; golden rules and heuristics; HCI patterns.

Section-C

Cognitive Models: Introduction to cognitive models; goal and task hierarchies; linguistic models; the challenge of display-based systems; physical and device models; cognitive architectures.

Socio-organizational Issues: Organizational issues including free rider problem, critical mass, workflow and BPR in automating processes; capturing requirements - stakeholders, socio-technical models, soft systems methodology, participatory design and ethnographic methods.

Case Studies: HCI in health care; user-centered designs in games.

Suggested Books:

1. Dix, A., Finlay, J., Abowd, G.D., & Beale, R. (2008). Human-Computer Interaction (3rd ed.). Pearson Education.
2. Carroll, J. M. (2002). Human-Computer Interaction in the New Millennium. Pearson Education.

Reading Elective

CS 509R Client-Server Computing and Applications

Max. Marks : 100

L	T	P	C
0	0	0	2

Learning Outcomes:

On successful completion of the course students will be able to

- Understand real life application using client-server architecture.
- Learn concepts of network and its usage in client-server model.
- Design distributed database for various application.

Distributed systems and database. Client-Server computing model, client-server hardware and software needs, issue in client server computing-shared access, connectivity, security, Advantages of client-server computing. Example: UNIX and Windows NT.

Client-server applications: Database server networks gateways, video-conferencing and multimedia applications. Client server architectures: Segmentation, switched FDDI, peer-to-peer architecture.

Suggested Books:

1. Dewire, D. T. *Client Server Computing* (1st ed.). Tata McGraw-Hill.
2. Berson, A. *Client Server Architecture*. Tata McGraw-Hill.
3. Orfali, R., Harkey, D., & Edwards, J. (2007). *Client Server Survival Guide* (3rd ed.). John Wiley & Sons.
4. Trivedi, M., Khanna, M.*Client Server Computing*. Book Publishing Co. Pvt. Ltd.

CS 522R Electronic Commerce

Max. Marks : 100

L	T	P	C
0	0	0	2

Learning Outcomes:

On successful completion of the course students will be able to

- Recognize the business impact and potential of e-Commerce.
- Explain the technologies required to make e-Commerce viable.
- Discuss the current drivers and inhibitors facing the business world in adopting and using e-Commerce.
- Explain the economic consequences of e-Commerce.
- Discuss the trends in e-Commerce and the use of the Internet.
- Create and refine ecommerce website and application designs based on industry's usability standards.

- Assess the suitability of various design principles for ecommerce websites and applications apply the technologies required to design and prototype Web-based information systems.
- Discuss e-commerce from an enterprise point of view evaluate key aspects of B2B e-commerce.
- Discuss emerging e-commerce topics.

Section-A

Whats and hows of Internet: Development and growth, DNS, Commercialisation of internet. Introduction to e-commerce: e-commerce, Opportunities, Framework, Recent Developments. Planning for Network Infrastructure & Web Architecture, Recent trends.

Section-B

Introduction to Internet Protocols: Layers and Networking, Internet Protocol suite, Desk topTCP/IP, Mobile TCP/IP based Networking, Multicast IP.

Principles of Web Site Hosting and Promotion: Decision on Website Design, Legal issues, Domain Name Registration, Site Hosting,Web Site Registration, Offline & online web site promotion.

Section-C

E-commerce Business Models : Brokerage, Advertising, Infomediary, Merchant, Manufacturer, Affiliate, Community, Subscription, Utility, Tried and True models. Auctions as a price setting mechanism, Pricing Information, Versioning Information. Cyberlaws, Electronic payment systems: Digital cash.

Suggested Books:

1. Turban, E., King, D., Lee, J., & Viehland, D. (2002). *Electronic Commerce: A Managerial Perspective*. PHI Learning.
2. Kalakota, R., & Whinston, A. B. *Frontiers of E-Commerce*. Pearson Education.
3. Chan, H., Lee, R., Dillon, T., & Chang, E. (2007*). E-Commerce: Fundamentals and Applications*. John Wiley & Sons.

IT 403R Enterprise Resource Planning

Max. Marks : 100

L	T	P	C
0	0	0	2

Learning Outcomes:

On successful completion of the course students will be able to

- Make students able to learn fundamental concepts of ERP system and ERP related technologies.
- Provide students knowledge of different ERP modules and manufacturing perspectives of ERP.
- Use ERP system in different business organizations by having knowledge of latest scenario of ERP market in e-business.

Section-A

Introduction to ERP - Predecessors (DSS, MIS, EIS, MRP-I, M'RP-11, MRP-III), Origin, Evolution, and Structure; ERP Overview; Reasons for the growth of ERP market, ERP Benefits - Direct and Indirect; Reasons for failure of ERP Implementations; Reasons Organizations should implement ERP; ERP andrelated Technologies; Business Process Re-Engineering (BPR) - Evolution and different Phases; Data Warehousing - Advantages, Components, Structure, Uses, and Obstacles to successful Data Warehouse Projects; Data Mining Verification v/s Discovery, Advantages, Technologies used, OLAP- 12 rules, OLAP benefits. Introduction to MOLAP, DOLAP, and ROLAP: Supply Chain Management (SCM) - Objectives , Enabling Technologies; Expert System

Section-B

ERP - A Manufacturing Perspective - CAD/CAM, MRP-II, BOM, Closed Loop MRP, DRP, J1T & Kanban, PDM (Product Data Management) & its benefits, Data Management, MTO v/s MTS, ATO, ETO, CTO; The Best Practices in ERP; ERP Modules - Finance, Plant Maintenance, Quality Management, Materials Management; ERP Market -SAP AG, BaaN, J D Edwards, Oracle, PeopleSoft; ERP in India

ERP Implementation Life Cycle - Different Phases, Approaches; ERP Implementation - Problems in Implementation; Cost of ERP - The Hidden Costs; Implementation Methodology; Organizing the Implementation; Key Players in Implementation - Vendors, Consultants, Users; Contracts with Vendors, Consultants, Employees; Project Management & Monitoring; After ERP Implementation; In-house Implementation - Pros & Cons

Section-C

The ERP Market - Vendor analysis; Turbo Charge the ERP; Enterprise Integration Applications (EIA); Future Directions in ERP - New Channels, New Markets, Faster Implementation methodologies. Business Models & BAPIs, Web Enabling; ERP & the World Wide Web - E-Commerce, Background, Using ERP though ASP; Making ERP a Success; Critical factors guiding Selection and Evaluation; Strategies for successful Implementation; Impediments & initiatives to achieve success; CSF (Critical Success Factors);

Integrating ERP into Organizational Culture; ERP Case Studies

Using ERP Tool: Either SAP or ORACLE formats for Case Study.

Suggested Books:

1. Leon, A. (2014). *Enterprise Resource Planning*. Tata McGraw-Hill.
2. Leon A. (2001).*ERP Demystified*. Tata-McGraw Hill.
3. Monk, E., & Wagner, B. (2012*). Concepts in Enterprise Resource Planning*. Cengage Learning.
4. Altekar, R. V. (2004*). Enterprisewide Resource Planning: Theory and Practice*. PHI Learning.
5. Jacobs, F. R., & Whybark, D. C. (2000). *Why ERP? A Primer on SAP Implementation*. Tata McGraw-Hill.

MCA VI Semester

Online Course Reading Electives

Agile Software Development

L	T	P	C
0	0	0	2

https://www.edx.org/course/agile-software-development

ETH Zurich

Learning Outcomes:

On successful completion of the course students will be able to

- Understand basic of agile model for software development
- Understand roles of agile values
- Understand testing management

Brief description

This course cuts beyond the agile methodology hype and teaches you the fundamental agile concepts that span a wide range of methodologies. It analyses the key agile ideas, their benefits, their limitations, and how best to take advantage of them to enhance your software skills and show employers that you have mastered an essential component of today's IT industry.

Brief Course outline

- Context, the Agile Manifesto, Agile Methods, Official Agile Principles, Agile Values
- Principles, the enemy: Big Upfront Anything, organizational principles, technical principles, a few method-specific principles
- Roles, traditional manager roles, the three Scrum roles, other Agile roles
- Practices, meetings, development, release, testing, management
- Artifacts, from user stories to burn down charts, assessment on Agile methods

Organizational Behaviour

L	T	P	C
0	0	0	2

Brief description

Learning Outcomes:

On successful completion of the course students will be able to

- Understand and apply principles of organizational dynamics relating to systems, culture, structure• and change processes
- Develop critical analytical skills that will help them diagnose situations pertaining to human behaviour and generate effective solutions for the same.
- Understand performance behaviour at individual and group levels.
- Develop the ability to lead and motivate others to succeed.

Brief Course Outline

- Introduction to Organizational Behaviour: Concept of Organizational Behaviour (OB), History, Nature and scope of OB, Key elements in OB, Inter-disciplinary contribution to OB, Managerial Roles Individual Behaviour,
- Values & Personality: Concept of Individual Differences, Values commonly studied across culture, Fundamentals and Determinants of Personality, Big Five Dimensions, Personality Theory, Personality Traits
- Learning & Perception : Fundamentals of Learning, Learning Theories - Classical Conditioning Theory, Operant Conditioning Theory, Social Learning Theory, Behaviour Modification, Definition of Perception, Perceptual Process, Common Perceptual Errors

- Motivation : Basic concept of Motivation, Theories of Motivation – Maslow, Herzberg's Two Factor Theory, ERG, McClelland, Equity and Vroom's Expectancy Theory
- Leadership: Introduction, Leadership Theories - Trait Theories, Behavioural Theories and Situational Theories
- Group Dynamics : Defining and classifying groups, Stages of group development, Group Properties – Roles, Norms, Status, Size and Cohesiveness, Group Decision making
- Managing Change in Organization: Definition, Forces of Change, Causes for Resistance to Change, Overcoming Resistance to change, Force Field Analysis and Kotter's Model for Change
- Organizational Culture: Meaning, Strong Culture vs. Weak Culture, Creating & sustaining Culture, Socialization.

References:

- Robbins, S.P.Judge, T.A.•&, Sanghi, Seema. Organizational Behavior, Pearson.
- Pareek, U, Understanding Organizational Behavior, Oxford University Press.
- Luthans,F. .Organizational Behaviour, Tata McGraw Hill.
- Sekaran,U. Organizational Behaviour: Text and Cases, Tata McGraw Hill

Suggested E-Resources:

1. https://swayamgov.in/courses/5148-organizational-behaviour
2. https://www.mooc-list.com/course/organizational-behaviour-managing-people-coursera

Software as a Service

L	T	P	C
0	0	0	2

Learning Outcomes:

On successful completion of the course students will be able to

- Create more sophisticated apps by adding relationships between models in apps and by enhancing their apps with JavaScript.
- Learn about what happens after the apps are deployed to real users, including how to monitor performance, identify and fix common performance problems, and avoid compromising customer data.
- Learn how to apply Agile techniques to enhance and refactor legacy code, a critical skill for professional programmers.

Course Outline:

- How to form, organize and manage small programming teams
- Introduction to design patterns: what they are and how to recognize opportunities to apply them
- Using Rails for more advanced features like third-party authentication and elegantly expressing design patterns that arise frequently in SaaS.

References:

- Engineering Software as a Service (ELLS), Beta edition (0.10.1; 16-April-2013), by Fox and Patterson

Suggested E-Resources:

https://www.edx.org/course/software-service-uc-berkeleyx-cs-169-2x

Blockchain

L	T	P	C
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https://www.coursera.org/learn/blockchain-basics

Learning Outcomes:

On successful completion of the course students will be able to

- Understand concept of Block Chain Technology
- Understand Bitcoin protocol
- Understand hashing and cryptography foundations

Brief description

This course of the Blockchain provides a broad overview of the essential concepts of blockchain technology – by initially exploring the Bitcoin protocol followed by the Ethereum protocol – to lay the foundation necessary for developing applications and programming.

Brief Course Outline

- Basics of Ethereum blockchain, creating accounts, unlocking accounts, concept of miners, transacting, transfer Ethers, and check balances.
- Decentralized peer-to-peer network, an immutable distributed ledger and the trust model that defines a blockchain.
- Basic components of a blockchain (transaction, block, block header, and the chain) its operations (verification, validation, and consensus model) underlying algorithms, and essentials of trust (hard fork and soft fork).
- Hashing and cryptography foundations indispensable to blockchainprogramming, which is the focusof two subsequent specialization courses, Smart Contracts and Decentralized Applications (Dapps).