BANASTHALI VIDYAPITH

Master of Technology (Computer Science)
Master of Technology (Information Technology)

Curriculum Structure

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

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.

CONTENT

Discipline Elective

Reading Elective

Online Reading Elective

Master of Technology (Computer Science)
Programme Educational Objectives

The main objectives of the programme are:

- Practice with an expertise in academics, entrepreneurship, design and development in computing technology, or research in a specialized area of computer science and Engineering to pursue higher studies.

- Exhibit analytical, decision making and problem solving skills by applying research principles for handling real life problems with realistic constraints.

- Communicate the findings or express innovative ideas in an effective manner with an awareness of professional, social and ethical responsibilities.

- Practice and promote computing technologies for societal needs.

- Contribute to advancement of computer technology by means of research and lifelong learning.

Programme Outcomes

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

- **PO1.** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to evaluate, analyze, synthesize, model and integrate technologies to solve complex engineering problems.

- **PO2.** Problem analysis: Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

- **PO3.** Design/development of solutions: Design and develop a system to provide a wide range of potential, feasible and optimal solutions for critical and challenging engineering problems to meet desired needs within social areas such as economics, environmental, and ethics.

- **PO4.** Conduct investigations of complex problems: Research Skill extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

- **PO5.** Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **PO6.** The engineer 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 contemporary issues in providing technology solutions for sustainable development considering impact on economic, social, political, and global issues and thereby contribute to the welfare of the society.

- **PO8.** Ethics: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

- **PO9.** Individual and team work: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

- **PO10.** Communication: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

- **PO11.** Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

- **PO12.** Life-long learning: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

Master of Technology (Information Technology)

Programme Educational Objectives

The main objectives of the programme are:

- Practice with an expertise in academics, entrepreneurship, design and development in information technology, or research in a specialized area of information technology to pursue higher studies.

- Identify and evaluate current and changing information system methodologies and assess their applicability in regulatory demands, strategic goals to address the clients' needs.

- Exhibit analytical, decision making and problem solving skills by applying research principles for handling real life problems with realistic constraints.

- Communicate the findings or express innovative ideas in an effective manner with an awareness of professional, social and ethical responsibilities.

- Practice and promote information technologies for societal needs.

- Contribute to advancement of information technology by means of research and lifelong learning.

Programme Outcomes

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

- **PO1.** **Engineering knowledge:** Apply knowledge of Information Technology, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge to solve emerging IT based problems.

- **PO2.** **Problem analysis:** Analyze complex Information Technology related problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

- **PO3.** **Design/development of solutions:** Design and develop a system to provide a wide range of potential, feasible and optimal solutions for critical and challenging information technology based problems to meet desired needs within social areas such as economics, environmental, and ethics.

- **PO4.** **Conduct investigations of complex problems:** Research Skill extract information pertinent to unfamiliar problems in information technology domain through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

- **PO5.** **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools of information technology including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **PO6.** **The engineer 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 contemporary issues in providing IT solutions for sustainable development considering impact on economic, social, political, and global issues.

- **PO8.** **Ethics:** Acquire professional and intellectual integrity, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society using information technology solutions.

- **PO9.** **Individual and team work:** Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research.

- **PO10.** **Communication:** Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

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Curriculum Structure
Master of Technology (Computer Science)
First Year

Semester - I

Course Code		Course Name	L	T	P	C*
CS	419	Distributed Computing	4	0	0	4
CS	431	Real Time Systems	4	0	0	4
CS	433	Soft Computing	4	0	0	4
CS	520L	Discipline Labs – I	0	0	12	6
		Discipline Elective - I	4	0	0	4
		Discipline Elective - II	4	0	0	4
		Semester Total:	**20**	**0**	**12**	**26**

Semester - II

Course Code		Course Name	L	T	P	C*
CS	503	Advanced Computer Architecture	4	0	0	4
CS	505	Advanced Topics in Algorithms	4	0	0	4
CS	532S	Seminar	0	0	2	1
CS	521L	Discipline Labs – II	0	0	12	6
		Discipline Elective – III	4	0	0	4
		Discipline Elective – IV	4	0	0	4
		Open Elective	4	0	0	4
		Semester Total:	**20**	**0**	**14**	**27**

Second Year

Semester - III

Course Code		Course Name	L	T	P	C*
CS	610P	UIL Project Part-I	0	0	48	24
		Reading Elective - I	0	0	0	2
		Semester Total:	**0**	**0**	**48**	**26**

Semester - IV

Course Code		Course Name	L	T	P	C*
CS	611P	UIL Project Part-II	0	0	48	24
		Reading Elective - II	0	0	0	2
		Semester Total:	**0**	**0**	**48**	**26**

List of Discipline Elective

Course Code		Course Name	L	T	P	C*
CS	302	Data Communications and Networks	4	0	0	4
CS	314	Systems Programming	4	0	0	4
CS	315	Theory of Computation	4	0	0	4
CS	406	Compiler Design	4	0	0	4
CS	411	Computer Graphics	4	0	0	4
CS	417	Database Management Systems	4	0	0	4
CS	423	Java Programming	4	0	0	4
CS	427	Parallel Computing	4	0	0	4
CS	602	Digital Image Processing	4	0	0	4
CS	436	Web Development and .NET Framework	4	0	0	4
CS	501	Advanced Communication Networks	4	0	0	4
CS	504	Advanced Java Programming	4	0	0	4
CS	507	Artificial Intelligence	4	0	0	4
CS	511	Cloud Computing	4	0	0	4
CS	514	Computer Architecture and Organization	4	0	0	4
CS	519	Data Warehouse and Data Mining	4	0	0	4
CS	526	Machine Translation	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	530	Neural Networks	4	0	0	4
ELE	502	Discrete Time Signal Processing	4	0	0	4
ELE	503	Embedded Systems	4	0	0	4
ELE	505	Microprocessor and Microcomputer Applications	4	0	0	4
IT	505	Geographic Information System	4	0	0	4
IT	506	Human Computer Interaction	4	0	0	4
IT	507	Information Retrieval	4	0	0	4
IT	511	System Testing	4	0	0	4
CS	508	Big Data Analytics	4	0	0	4
IT	412	Internet of Things	4	0	0	4

List of Reading Elective

Course Code		Course Name	L	T	P	C*
IT	402R	Electronic Commerce	0	0	0	2
IT	403R	Enterprise Resource Planning	0	0	0	2
IT	604R	Semantic Web	0	0	0	2

List of Online Reading Elective

Course Code	Course Name	L	T	P	C*
	Machine Learning	0	0	0	2
	Agile Software Development	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 the Vidyapith 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 Technology (Information Technology)
First Year

Semester - I

Course Code		Course Name	L	T	P	C*
CS	533	Software Engineering	4	0	0	4
IT	501	Advanced Database Management Systems	4	0	0	4
IT	502L	Discipline Labs - I	0	0	12	6
IT	504	Distributed Systems	4	0	0	4
		Discipline Elective - I	4	0	0	4
		Discipline Elective - II	4	0	0	4
		Semester Total:	**20**	**0**	**12**	**26**

Semester - II

Course Code		Course Name	L	T	P	C*
CS	525	Information Security Systems	4	0	0	4
IT	510	Software Architecture and Project Management	4	0	0	4
IT	508P	Minor Project	0	0	8	4
IT	509S	Seminar	0	0	2	1
IT	503L	Discipline Labs - II	0	0	12	6
		Discipline Elective – III	4	0	0	4
		Open Elective	4	0	0	4
		Semester Total:	**16**	**0**	**22**	**27**

Second Year

Semester - III

Course Code		Course Name	L	T	P	C*
IT	605P	UIL Project Part-I	0	0	48	24
		Reading Elective - I	0	0	0	2
		Semester Total:	**0**	**0**	**48**	**26**

Semester - IV

Course Code		Course Name	L	T	P	C*
IT	606P	UIL Project Part-II	0	0	48	24
		Reading Elective - II	0	0	0	2
		Semester Total:	**0**	**0**	**48**	**26**

List of Discipline Elective

Course Code		Course Name	L	T	P	C*
CS	302	Data Communications and Networks	4	0	0	4
CS	314	Systems Programming	4	0	0	4
CS	315	Theory of Computation	4	0	0	4
CS	406	Compiler Design	4	0	0	4
CS	411	Computer Graphics	4	0	0	4
CS	417	Database Management Systems	4	0	0	4
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CS	427	Parallel Computing	4	0	0	4
CS	602	Digital Image Processing	4	0	0	4
CS	436	Web Development and .NET Framework	4	0	0	4
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CS	504	Advanced Java Programming	4	0	0	4
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CS	526	Machine Translation	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	530	Neural Networks	4	0	0	4
ELE	502	Discrete Time Signal Processing	4	0	0	4
ELE	503	Embedded Systems	4	0	0	4
ELE	505	Microprocessor and Microcomputer Applications	4	0	0	4
IT	505	Geographic Information System	4	0	0	4
IT	506	Human Computer Interaction	4	0	0	4
IT	507	Information Retrieval	4	0	0	4
IT	511	System Testing	4	0	0	4
IT	412	Internet of Things	4	0	0	4
CS	508	Big Data Analytics	4	0	0	4

List of Reading Elective

Course Code		Course Name	L	T	P	C*
IT	402R	Electronic Commerce	0	0	0	2
IT	403R	Enterprise Resource Planning	0	0	0	2
IT	604R	Semantic Web	0	0	0	2
IT	601R	Information and Communication Technology	0	0	0	2

List of Online Reading Elective

Course Code	Course Name	L	T	P	C*	*
	Machine Learning	0	0	0	2	
	Agile Software Development	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 the Vidyapith 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

Continuous Assessment (CA)					End-Semester Assessment	Grand Total
(Max. Marks)					(ESA)	(Max. Marks)
Assignment		Periodical Test		Total		
I	II	I	II	(CA)	(Max. Marks)	
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:

Letter Grade	Grade Point	Narration
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C+	5	Average
C	4	Below Average
D	3	Marginal
E	2	Exposed
NC	0	Not Cleared

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 ith course with letter grading and GP_i is the letter grade point obtained in the ith 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	7.50 and above
First Division	6.00 to 7.49
Second Division	5.00 to 5.99
Pass	4.00 to 4.99

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

Master of Technology (Computer Science)

First Semester

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

- Understand the hardware and software concepts of distributed operating systems, various design issues 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

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. Introduction to distributed databases.

Section B

Distributed Algorithms : Introduction to distributed algorithms, synchronous and partial synchronous models, Algorithms in general synchronous leader election, Breadth first search, shortest path, randomized algorithms. Distributed concensus 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, resource allocation, concensus, Asynchronous network model, basic asynchronous network algorithms, shared memory Vs Networks. Introduction to parallel distributed processing : general framework, methods of learning.

Suggested Books:

1. Sinha, P. K. (2002). *Distributed operating systems* PHI Learning Pvt. Ltd..

2. Nancy A. Lynch(2009), *Distributed Algorithms,* Morgan Kaufmann Publishers

3. Kshemkalyani, A. D., & Singhal, M. (2011). *Distributed computing: principles, algorithms, and systems*. Cambridge University Press.

4. Tanenbaum, A. S. (2009). *Distributed operating systems*. Pearson Education India

5. David E. Rumelhart, James L. McClelland and the PDP Research Group(1999), *Parallel Distributed Processing* , Vol. 1, Vol. 2, MIT Press,

6. Haykin, S. (1999). *Neural networks*.IEEE Press II ed.

Suggested E-Resources:

1. Distributed Systems
   https://nptel.ac.in/courses/106106168/

2. Tanenbaum, A. S., & Van Steen, M. (2007). *Distributed systems: principles and paradigms*. Prentice-Hall.

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

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.

Section-A

Definition of RTS, Issues in real time computing –Constraints, Structure of RTS.

Model of Real-Time Systems: Processors and resources, Parameters of real time workload, Periodic task Model, Aperiodic and Sporadic Tasks, Precedence constraints and data dependency, Other types of dependencies, functional Parameters, resource parameters of jobs and parameters of resources.

Performance measures of RTS- properties of performance measure, Performabitity - cost function and hard deadline - Estimating program real time, Analysis of source code, pipelining, dependencies.

Real-time system design: system-development life cycle, design Issues, Hardware considerations, Real Time Kernel: features of RTOS, inter-process communication: Messages, Buffers, mailboxes, queues, semaphores, deadlock, priority inversion, Language Considerations.

Section-B

Priority-Driven scheduling of periodic task:

Fixed-priority, dynamic priority algorithm, rate-monotonic and

Deadline monotonic algorithm, EDF algorithm, optimality of the RM and EDF Algorithm. Resources and Resource Access Control:

Resource contention and resource access control, Basic Priority-

Inheritance Protocol, Basic Priority ceiling Protocol, Scheduling Aperiodic and sporadic Tasks.

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:

Network topologies- Sending messages, Network architecture issues, Protocol -Contention based, Token based. Stop & Go Multi hop Protocol. The Pooled

Bus. Hierarchical Round Robin Deadline, based. Fault tolerant Routing,

Fault tolerance techniques: Causes of failure, fault types, fault detection, redundancy, and integrated failure handling.

Reliability Evaluation techniques: Parameter values, reliability model for hardware redundancy, software error model, introduction to clock synchronization.

CS 433 Soft Computing

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

Learning Comes:

On successful completion of the course students will be able to

- Develop NN network based application.

- Differential between supervised, unsupervised and reinforcement learning.

- Apply fuzzy logic on real life problems.

- Design Hybrid Systems viz Neuro-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*. Prentice Hall PTR..

2.   Klir, G. J. (2010), *Fuzzy sets and fuzzy logic: theory and applications*, Prentice- Hall.

3. Goldberg, D. E(2007). .*Genetic algorithms in search optimization and machine learning*, Pearson, .

4. Jang, J. S. R., *Neuro-Fuzzy and soft computing: a computational approach to learning and machine intelligence*, Prentice-Hall,,

5. Freeman, J. A.(2002), *Neural networks: algorithms, applications and programming techniques ,*Pearson.

6. Kosko, B. (2003). Neural networks and fuzzy systems: a dynamical systems approach to machine intelligence, *Prentice hall*.

7. Li, H., Li, H. H., & Gupta, M. M. (Eds.). (1995). *Fuzzy logic and intelligent systems* (Vol. 3). Springer Science & Business Media

8. Zimmermann,H. J(1996), *Fuzzy set theory and applications,* Allied Publishers,1996.

9. Driankov, D., Hellendoorn, H., & Reinfrank, M. (1996). *An Introduction to Fuzzy Control,*Narosa Publishers

10. Mitchell, M. (1998). *An introduction to genetic algorithms*. MIT press.

11. Rajasekaran, S., & Pai, G. V. (2003). *Neural networks, fuzzy logic and genetic algorithm: synthesis and applications (with cd)*. PHI Learning Pvt. Ltd..

12. Yegnanarayana, B. (2003). *Artificial neural networks*. PHI Learning Pvt. Ltd...

Suggested E-Resources:

1. Neuro-Fuzzy and Soft Computing

   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

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

Second Semester

CS 503 Advanced Computer 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

- Use the concepts and design of all type of sequential, combinational circuits for modern processor.

- Have knowledge to design and conduct experiments, as well as to analyze of the hardware of a parallel computer models,Multiprocessors.

- Design techniques such as pipelining and microprogramming in the design of the central processing unit of a computer system.

- Identify, formulate, and solve problems for vector processing.

Section A

Overview of modern processor architectures. Processor Design. Memory Hierarchy - Cache and Cache Coherence, Bus Architecture, Types of parallel machine. Vector Pipeline Architectures (Replicated Architectures, Shared Memory, Distributed Memory).

Section B

Parallel Computer Models: The state of computing, multiprocessors and multicomputers, multivector and SIMD computers, architectural development tracks. Program and Network Properties: conditions of parallelism, program partitioning and scheduling.

Section C

Linear Pipeline Processors, Nonlinear Pipeline processors, Instruction Pipeline Design, Arithmetic Pipeline Design, Multiprocessors System Interconnects, Vector Processing Principles, Multivector Multiprocessors and Data Flow Architecture.

Suggested Books:

1. Hwang, K.(1993). *Advanced Computer Architecture,* McGraw-Hill Education.

2. Sima D, FOUNTAIN, T., & Kacsuk, P. (2003). *Advanced computer architectures: a design space approach*. Pearson Education India.

3. Patterson, D. A., & Hennessy, J. L. (2000). *Computer Organization and Design (*2nd ed) kaufmann.

4. Hayes J.P.(1998),*Computer Architecture and Organization(* 3rd ed), McGraw Hill.

5. Cragon, H. G. (1998). *Memory systems and pipelined processors*. Narosa Publication.

6. Ghose R. K., Moona R. & Gupta Phalguni(1995),*Foundation of Parallel Processing,* Narosa Publications.

7. Hwang, K., & Xu, Z. (1998). *Scalable parallel computer architecture,* McGraw-Hill.

8. Stalling W(2006),*Computer Organization & Architecture(*7th ed), Pearson .

Suggested E-Resources:

1. Advanced Computer Architecture

    https://www.iitg.ac.in/asahu/cs523e/

2. Computer Architecture

    https://www.coursera.org/learn/comparch

CS 505 Advanced Topics in Algorithms

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

- Analyze the performance of various algorithms in terms of time and space and understand the concept of Amortization.

- Understand the concept and design of algorithms including matching, flow and circulator problems

- Understand numerous algorithm design techniques for problems like min-cut, Monte Carlo, minimum spanning tree.

- Choose appropriate algorithm design techniques for solving real world problems.

- Ability to understand how the choice of the algorithm design methods impact the performance of programs

Section - A

Analyzing algorithms, Lower and Upper bounds, Analysis of Heap sort and quick sort. Amortization, advanced Data Structures: B Trees, Bionomial heaps, Fibonacci heaps, the Union-Find data structure, splay trees

Section - B

Advanced algorithms: Theory of NP-completeness and approximation algorithms for NP Completeness problems (cg vertex cover, travelling

salesman), Planar and plane graphs, the planar separator theorem and applications, Algorithms for Matching, flow and circulator problems, A discussion on Parallel Algorithms.

Section - C

Algorithms in number theory : GCD, Chinese Remainder theorem, Polynomial roots and factors, Primality testing.

Randomized Algorithms: Introduction, Las Vegas and Monte Carlo, The min-cut problem, Minimum spanning trees, Binary planar partitions.

Suggested Books:

1. Cormen Thomas H. ,Leiserson Charles E., Rivest Ronold L. *Introduction to Algorithms*. MIT Press

2. Motwani Rajeev and Raghavan Prabhakar *Randomized Algorithms*, Cambridge University Press,

3. Kozan Dexter C., The Design & Analysis of Algorithms, Springer-Verlag, 1991.

4. Aho, Hopcraft & Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley, 1975.

5. Garey M.R and Johnson D.S, Computers & Intractability: A 6.Guide to the Theory of NP-Completeness, W.H. Freeman, 1979.

7. Tarjan R.E., Data Structures and Network Algorithms. SIAM Regional Conference series in Applied Mathematics 44, 1983.

8. Berman K.A., Paul J.L., Algorithms, Cengage Learning

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/

Master of Technology (Information Technology)

First Semester

CS 533 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 and implement the concept of SDLC

- Understand the concept of project management

- Apply software quality assurance practices to ensure that software designs, development, and maintenance.

- Perform various testing techniques

Section A

Introduction to Software engineering concepts, Software processes-Software Project Management, Software Configuration Management, Process Management, Software Requirement Specification (SRS) - problem analysis, structured analysis, object oriented modeling, ER and other modeling approaches, Prototyping. Project Planning, software metrics, project monitoring plans, Risk management, overview of ISO 9000, CMM, SEI.

Section B

Design principles, Modularity, Data Structures, Information Hiding, Cohesion, Coupling, Analysis modeling (SADT, JSD, DSSD, Warner Diagram), Function Oriented Design, Object Oriented Design, Design Notations and specifications, Detailed design, Logic / Algorithmic design, Specification Languages, Design metrices, source code (Halstead, Cyclomatic complexity), Component level design, Real time system design, Coding - Programming Practice, Top down, Bottom up, Structured programming, Object Oriented programming, style, Internal Documentation.

Section C

Software Testing, white box testing, Black box testing, Structural Testing. Test case generation and tool support. Object oriented program testing, State based testing, Incremental testing, Testing process, Level of testing, Test Plan, Test Case specification. Software Testing Strategies, System testing, Maintenance metrices (SMI, BMI, %bad fix), Debugging, Re-engineering.

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. Fairley, R. (1997). *Software Engineering Concepts*. Tata McGraw-Hill.

4. Mall, R. (2004). *Fundamentals of Software Engineering*. PHI Learning, New Delhi.

5. Sommerville, I. (2008). *Software Engineering*. Pearson Education.

Suggested E-Resources:

1. Software Engineering

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

2. Pressman, R. S. (2005). *Software engineering: a practitioner's approach*. Palgrave Macmillan.

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

IT 501 Advanced 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

- Learn basic concepts of Intelligent, Object relational Databases.

- Understand components of active, object, and deductive database

- To have knowledge of temporal, spatial, multimedia, mobile and web databases

- Able to write down queries in XML for parallel databases and information retrieval.

- Learn various security and authorization details related with advance database management system.

Section A

INTELLIGENT DATABASES :

Active Databases- passive (conventional) vs. active databases, syntax and semantics of active databases (Starburst, Oracle, DB2), applications, Design principles, Rule modularization, Rule debugging, Rule monitoring, IDEA methodology.

OBJECT AND OBJECT RELATIONAL DATABASES:

Introduction to Object–Oriented Data models ,Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance – Complex Objects , Object Reference.

Relational Extensions: Object Relational DBMS Database design for an ORDBMS, Query processing and optimization issues, overview of SQL3, Comparison of ORDBMS and OODBMS.

DEDUCTIVE DATABASES:

Logic of Query Languages – Datalog- Recursive Rules-Syntax and Semantics of Datalog Languages- Implementation of Rules and Recursion- Recursive Queries in SQL.

Section B

Temporal Databases: Temporal projection and join, Time domain, Time data types, Fact Association with time, Time ontology, Data Model, Language constructs.

Spatial, Text & Multimedia Databases: Traditional indexing Methods; secondary keys, special access methods, text retrieval, Multimedia Indexing; 1-D Time Series, 2-D Color Images, Subpattern Matching.

Mobile Databases: Data, processing and technology requirements.

Information Retrieval and XML Data: Web Search Engines, Information Retrieval and Structured Data, Directories. XML: structure, schema, querying and transformation, application program interface, storage of XML, XML applications.

Section C

Parallel Databases: Parallel Database Architectures, Parallel Query Evaluation, Data Partitioning, Parallelizing Sequential Operator Evaluation Code, Parallelizing Individual Operations.

Database Security and Authorization: Database Security Objective and Issues, Security Violations, Authorization (Access Rights), Access Control, Discretionary Control, Mandatory Access Control, Covert Channels, DoD Security Levels, Additional Issues Related to Security, Role of Database Administrators (DBA).

Suggested Books:

1. Connolly, T. M., & Begg, C. E. (2005). *Database systems: a practical approach to design, implementation, and management*. Addison Wesley.

2. Ramakrishnan, R., & Gehrke, J. (2000). *Database management systems*. McGraw Hill.

3. Harrington, J. L. (2000). *Object-oriented database design clearly explained*. Academic Press

4. Piattini, M., & Diaz, O. (2000). *Advanced database technology and design*. Artech House, Inc..

5. Garcia-Molina, H., Ullman, J. D., & Widom, J.(2008) *Database Systems: The Complete Book*, Pearson..

6. Lynne, D. (2003). *Multimedia Databases: An Object Relational Approach*. Pearson Education India.

7. Teorey, T. J., Lightstone, S. S., Nadeau, T., & Jagadish, H. V. (2011). *Database modeling and design: logical design*. The Morgan Kaufmann Series in Data Management Systems

8. Prabhu, C. S. R. (2004). *Object oriented database systems*. Prentice-Hall of India Pvt. Ltd.

9. Leon, A., & Leon, M. (2010). *Database management systems*. Vikas Publishing House Pvt. Limited.

10. Zaniolo, C., Ceri, S., Faloutsos, C., Snodgrass, R. T., Subrahmanian, V. S., & Zicari, R. (1997). *Advanced database systems*. Morgan Kaufmann.

Suggested E-Resources:

1. Advanced Database Systems
    https://www2.cs.duke.edu/courses/spring05/cps216/LectureNotes.html

2. Advanced DBMS
    http://www.cse.iitb.ac.in/infolab/Data/Courses/CS632/

IT 504 Distributed 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

- Understand distributed systems concepts and issues.

- Understanding of communication, naming and file system in distributed system

- Learn synchronization and fault tolerance mechanism, security in distributed systems

- Basic understanding of Parallel Distributed Processing& learning

Section A

Characterization of Distributed Systems: Introduction, Examples of distributed systems, Distributed system models, Issues in design of distributed operating system, message passing, synchronization, process management, resource management; Case studies: DCE, Unix IPC, SUN RPC.

Section B

Communication : Remote Procedure Calls, Remote Object Invocation, Message oriented Communication, Stream oriented Communication, Distributed file systems: Concurrency control, replicated files, consistency, Introduction to distributed data-base

Section C

Naming: Names, Identifiers, and Addresses, Name Resolution, The Implementation of Name Space, The Domain Name System.

Fault tolerance: Basic Concepts, Failure Models, Failure Masking by Redundancy, Security : Threats, Policies, and Mechanisms, Design Issues, Secure Channels, Access Control, Security Management, Introduction to Parallel Distributed Processing: General Framework, Methods of Learning; Case studies: Distributed OS, Amoeba, V-system

Suggested Books:

1. Tanenbaum, A. S. (2009). *Distributed Operating Systems*. Pearson Education .

2. Coulouris, G. F., Dollimore, J., & Kindberg, T. (2005). *Distributed systems: concepts and design*. pearson education.

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

4. Rumelhart D.F, McClelland JI & PDP Group (1999). *Parallel Distributed Processing,* vol I&II, MIT Press.

5. Garg, V. K. (2012). *Principles of distributed systems* , Kluwer Academic

Suggested E-Resources:

1. Distributed Systems
   https://nptel.ac.in/courses/106106168/

2. Tanenbaum, A. S., & Van Steen, M. (2007). *Distributed systems: principles and paradigms*. Prentice-Hall.

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

Second Semester

CS 525 Information Security Systems

	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

- Able to apply cryptography algorithms in real world problems.

- Understand need of security for information.

- Learn the role of digital signatures and cyber cash in digital world.

Section A

Foundations of Cryptography and Security, Ciphers and Secret Messages, Security Attacks and Services, Mathematical Tools for Cryptography, Substitutions and Permutations, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Discrete Logarithms, Conventional Symmetric Encryption Algorithms, Theory of Block Cipher Design, DES and Triple DES, Modes of Operation (ECB,CBC, OFB,CFB), Strength of DES, Modern Symmetric Encryption Algorithms, IDEA, RC2, RC5, Rijndael (AES), Stream Ciphers and Pseudo Random Numbers, One Time Pad, Cryptanalysis

Section B

Public Key Cryptography, Prime Numbers and Primality testing, Factoring Large Numbers, RSA, Cryptanalytic attacks on RSA, Diffie-Hellman Algorithm, Hashes and Message Digests, Message Authentication, MD5, SHA, HMAC, Digital Signatures, Digital Signature Standard (DSS and DSA), Elliptic Curve Cryptosystems.

Section C

Authentication of Systems, Kerberos (V4 and V5) , Electronic Mail Security (Pretty Good Privacy, S/MIME) , IPSec and Web Security, Intrusion detection systems, Secure Sockets and Transport Layer (SSL and TLS), Electronic Commerce Security, Electronic Payment Systems, Secure Electronic Transaction (SET), Cyber Cash, Digital Watermarking and Steganography

Suggested Books:

1. Schneier, B. (2006). *Applied cryptography: protocols, algorithms, and source code in C(2ed)*. john wiley & sons.

2. Stallings, W. (2011). *Cryptography and Network Security,(4ed)*. Pearson Education India.

3. Katz, J., Menezes, A. J., Van Oorschot, P. C., & Vanstone, S. A. (1996). *Handbook of applied cryptography*. CRC press.

4. Schneier, B. (2004). *Secrets and lies: digital security in a networked world*. John Wiley & Sons.

Suggested E-Resources:

1. Introduction to Computer Security

    https://www.cs.northwestern.edu/~ychen/classes/cs350-w07/lectures.html

2. Cryptography and Network Security
    https://nptel.ac.in/courses/106105031/

IT 510 Software Architecture and Project Management

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 development cycle

- Understand the ways to deal with existing software architecture and how to interpret them for the new product development

- Apply basic software quality assurance practices to ensure that software designs, development, and maintenance meet or exceed applicable standards

Section A

Review of software engineering concepts: Principles of software engineering, Features of good software. Quality Requirement in different Application Areas **Software Process:** Software Process and Models, Tools and techniques of Process Modeling, Product and Process

Introduction to Project Management: Definition of the project. Project specification and parameters. Principles of Project management, Project management life cycle

Software Project Planning: Project activities and Work Breakdown Structure (WBS), Criteria for completeness in the WBS, Activity Resource Requirements and Cost, Joint Project Planning Session, Project Management Plan

Case Study

Section B

Project Economics: Project Costing, Empirical Project Estimation Techniques, Decomposition Techniques, Algorithmic methods, Automated Estimation Tools

Project Scheduling and Tracking Techniques: Why are projects delayed? Effort Estimation Techniques, Task Network and Scheduling Methods, Monitoring and Control Progress, Graphical Reporting Tools.

Risk Analysis and Management: Risk Concepts and Identification, Risk Assessment and Control, Risk Components and Drivers, Risk Tracking and Monitoring, Risk Mitigation and Management.

Software Metrics and Project Management: Measures, Metrics and Indicators, Process and project metrics. Statistical Metrics and Process Monitoring, Function-point and project management

Case Study

Section C

Project Management Issues with regard to New Technologies: Object-oriented Methodology, Web-based Projects, Embedded Systems.

Software Architecture: Introduction to Software Architectures, Origin & design process of Software Architectures, Quality Attributes, Scope of software architecture, architectural styles. Software architectural design.

Suggested Books:

1. Hughes, B., & Cotterell, M. (1968). *Software project management*. Tata McGraw-Hill Education.

2. Mary, S., & David, G. (1996). Software Architecture: Perspectives on an Emerging Discipline. *Prentice-Hall*.

3. Jalote,P.(2001) *Software Project Management in Practice*, Addison-Wesley Professional,

4. Rakos, J. J. (1998). *Software project management for small to medium sized projects,* Prentice Hall.

5. Royce, W. (2001). *Software project management*: *A Unified Framework,* Addison-Wesley

6.   Norris, M., Rigby, P., & Payne, M. (1993). *The Healthy Software Project: A guide to successful development and management*. John Wiley & Sons, Inc..

7. Mynatt, B. T. (1990). *Software engineering with student project guidance*. Prentice-Hall, Inc..

8. Larson, E. W., & Gray, C. F. (2008). A Guide to the Project Management Body of Knowledge(4ed),Project Management Institute.

9. Whitten, N. (1995). *Managing software development projects: formula for success*. New York: Wiley.

Suggested E-Resources:

1. Software Engineering
   https://nptel.ac.in/courses/106101061/17
   Offered by: IIT Bombay

2. Software Product Management Specialization
   https://www.coursera.org/specializations/product-management
   Offered by: University of Alberta

Discipline Electives

CS 302 Data Communications and Networks

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

Learning Outcomes:

On successful completion of the course students will be able to

- Understand basic computer network technology
- Identify the different types of network topologies, protocols and network devices
- Understand the layers of the OSI and TCP/IP models
- Analyze the features and working of IPV4, IPV6 and their transition
- Understand and 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 314 Systems 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 concepts of System Software
- Enumerate and explain the function of the common operating system
- Learn Working of a compiler and text editor
- Understand MS DOS, ROM BIOS and Interrupt system

Section A

Components of System Software, evolution of system Software. General Machine structure (Memory, Register, Data Instructions). Assemblers,

Design of Two Pass Assembler. Macros and Macro Processors. Translators: Interpreters, Brief description of different phases of compiler.

Section B

Loaders : A Two Pass Loader Scheme, Relocating loader, subroutine linkage, Direct linking loader. Binders, Overlays. Types and basic functions of operating systems. Software Tools : Text Editors, Program Generator, Debug Monitors.

Section C

Access to system services : ROM BIOS, DOS, Mouse and EMS (Expanded memory specifications) Functions, KeyBoard and Screen Management. Introduction to Terminal Emulator. DOS Device Drivers : Types , Structure and Processing. Interrupt Types, Organisation, Interrupt Hardware, Program status register(PSR), Interrupt Processing.

Suggested Books:

1. Donovan, J. J., *Systems programming (1991).* Tata McGraw-Hill.

2. Duncan, R. (1994), *Advanced MS-DOS Programming*, BPB Publication

3. Ellzey, R. S. (1987). *Computer system software: the programmer/machine interface*. Pergamon Press, Inc..

4. Dhamdhere, D. M. (1987). *Introduction to system software*. Tata McGraw-Hill Pub.

5. BiggerStaff T. J(1986), *System Software Tools*, Prentice Hall.

6. Dhamdhere, D. M. (2001). *Systems Programming and Operating Systems(2ed)*. Tata McGraw-Hill.

7. Bose, S. K. (1991). *Hardware and Software of Personal Computers*. New Age International.

Suggested E-Resources:

1. System Programming

   http://solomon.ipv6.club.tw/Course/SP.941/

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

- Understand concepts in formal language theory, grammars, automata theory, computability theory, and complexity theory
- Understand abstract models of computing, including deterministic, non-deterministic, Push Down Automata and Turing machine models and their power to recognize the languages
- Relate practical problems to languages, automata, computability, and complexity.
- Apply mathematical and formal techniques for solving problems in computer science.

Section A

Mathematical preliminaries, alphabets, strings, Languages, states, transitions, finite automata 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. 32*(1), Narosa Publishing House

2. Wood, D., & Wood, D. (1987). *Theory of computation (Ist ed).* Harper & Row Publishers New York.

3. Lewis, H. R., & Papadimitriou, C. H. (2001). *Elements of the Theory of Computation*. Prentice-Hall. *Englewood Cliffs*.

Suggested E-Resources:

1. Theory of Computation

   https://nptel.ac.in/courses/106104028/

2. Linz, P. (2006). *An introduction to formal languages and automata*. Jones & Bartlett Learning.

   http://almuhammadi.com/sultan/books/Linz.5ed.pdf

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.

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, A. V., & Ullman, J. D. (1989). *Principles of Compiler Design* . Narosa Publishing House .

2. Ullman, J., Aho, A. V., & Sethi, R. (2007). *Compilers: Principles, techniques and tools*,Pearson.

3. Louden, K. C. (1989). *Compiler construction: Theory & Practice*, Galgotia Publication.

4. Tremblay, J. P ,Sorenson, P. G.(1985),*Theory and applications of Compiler Writing,* B. S. publication

5. Muchnick, S. (1997). *Advanced compiler design implementation*. Harcourt Asia

Suggested E-Resources:

1. Principles of Compiler Design

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

2. Compilers

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

CS 411 Computer Graphics

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

- Acquire 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
- Realistically display 3-Dimensional images on 2-Dimensional plane using projections, shading and illumination models.

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 algorithm. 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(2ed)*. Pearson Education.

2. Rogers, D. F., & Adams, J. A. (1990). *Mathematical elements for computer graphics*(2ed), McGraw-Hill Higher Education.

3. Newman, W. M., & Sproull, R. F. (1997). *Principles of interactive computer graphics(2ed)*. McGraw-Hill, Inc..

4. Harrington, S., Pace, K., & Goldberg, L. (1987). *Computer graphics: A programming approach(2ed)*, McGraw-Hill Inc.

5. Hughes, J. F., Van Dam, A., Foley, J. D., Feiner, S. K. (1996). *Computer graphics: principles and practice (2ed),* Pearson Education Asia.

6. Plastock, R. A., & Kalley, G. (1992). *Schaum's outline of theory and problems of computer graphics*. McGraw-Hill.

7. Mukhopadhyay A., Chattopadhyay A.(2007), *Introduction to Computer Graphics and Multimedia(2ed)*, Vikas Publishing House Pvt Ltd.

8. Rogers, D. F. (1998). *Procedural elements for computer graphics(2ed),* McGraw-Hill, Inc..

9. Xiang, Z., & Plastock, R. A. (1986). *Schaum's Outline of Computer Graphics*, Tata McGraw Hill

Suggested E-Resources:

1. Computer Graphics

   https://nptel.ac.in/courses/106106090/

2. Computer Graphics

   https://ocw.mit.edu/courses/electrical-engineering-and-computer science/6-837-computer-graphics-fall-2012/

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 s and Relational database.
- 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, intergrity constrainsts-keys constraints, domain constraints, referential integrity, assertions, triggers, security of Databases.

Section B

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

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. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2006). *Database system concepts* (5ed),Tata McGraw-Hill.

2. Murdick, R. G., Ross, J. E.,R. (1984). *Information systems for modern management,* PHI.

3. Date, C. J. (1990*). An introduction to database systems*. Addison Wesley.

4. Majumdar,A., Bhattachrya,P., *Database Management System* ,Tata McGraw-Hill.

5. Ramakrishnan, R., & Gehrke, J. (2000). *Database management systems.* 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
   https://www.coursera.org/learn/database-management

3. Silberschatz, A., Korth, H. F., & Sudarshan, S. (1997). *Database system concepts*. New York: McGraw-Hill.
   https://kakeboksen.td.org.uit.no/Database%20System%20Concepts%206th%20edition.pdf

CS 423 Java 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 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 and 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, Calendar, Random, Timer). Networking, Socket and Datagram programming.

Section C

JDBC, ODBC-JDBC Drivers, Types of Drivers, Prepared Statment, 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(7ed)*. McGraw-Hill Education Group.

2. Rajagopalan, S., Rajamani, R., & Ramesh, K. (2002). *Java Servlet Programming Bible(2002),* Delhi: Wiley Dreamtech India Pvt. Ltd.

3. Balagurusamy, E., (2007). *Programming with java(3ed)*. Tata McGraw-Hill.

4. Mughal, K. A., & Rasmussen, R. W. (2009). *A Programmer's Guide to Java SCJP Certification: A Comprehensive Primer (3rd*, Pearson Education

5. Arnold, K., Gosling, J., & Holmes, D. (2000). *The Java programming language(3ed)*., Pearson Education Pte. Ltd

6. Zukowski, J. (1998). *Mastering Java 2*. BPB Publications ,

7. Deitel, P. J., & Deitel, H. M. (2009). *Java: How to Program* . Pearson Education Limited.

8. Horstmann, C., & Cornell, G. (2005). Core Java 2: Volume I,II, Fundamentals.. Pearson Education Pte. Ltd

9. Haecke, B. V. (2000). *Jdbc: Java Database Connectivity with Cdrom*. IDG Books Worldwide, Inc..

10. Bayross, I. (2005). Web Enabled Commercial Applications Development Using... Java 2. BPB Publications

11. Ganguli, Madhushree(2002), *JSP: A Beginner's Guide.* , Wiley Dreamtech India Pvt. Ltd.

12. Liang, Y. D., (2012). *Introduction to Java programming*.(9ed), Pearson Education Pte. Ltd

Suggested E-Resources:

1. Java Lectures

   https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html

2. Object Oriented Programming in Java Specialization

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

CS 427 Parallel 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 computer program for different type of parallel computers
- Measure the performance of algorithm used and parallel computers
- Solve problem using parallel computers
- Transform sequential code segments to parallel code segments

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 computing*. PHI Learning Pvt. Ltd..

2. Quinn, M. J. (1987). *Designing efficient algorithms for parallel computers*. McGraw-Hill.

3. Lakshmivaraha, S., & Dhall, S. K. (1990). *Analysis and design of parallel algorithms: Arithmetic and matrix problems*. McGraw-Hill, Inc..

Suggested E-Resources:

1. Parallel Computing

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

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

- Code programs implementing fundamental image processing algorithms

- Conversant with the mathematical description of image processing techniques

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:

3. Digital Image Processing by Stanford University
   https://web.stanford.edu/class/ee368/

4. Digital Image Processing
   https://nptel.ac.in/courses/117105079/

CS 436 Web Development and .NET Framework

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 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

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). *The complete reference C# 3.0,* Tata McGraw-Hill Education.

2. Sklar, J(2010), *Textbook of Web Design*. Publisher Course Technology Sklar,

3. Evjen, B., Hanselman, S., & Rader, D. (2008). *Professional ASP. NET 3.5 SP1 Edition: In C# and VB*. Wrox Publication

4. Troelsen, A. (2008). *Pro C# and NET 3.5 Platform* ,Dreamtech Press.

5. Troelsen, A. (2007). *Pro C# With. Net 3.0*, Aprèss Publication.

Suggested E-Resources:

1. W3Schools website

   https://www.w3schools.com/asp/default.asp

2. ASP.NET Web Forms Tutorial

   https://asp.net-tutorials.com/basics/introduction/

CS 501 Advanced Communication 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

- Learn TCP/IP protocol and various routing algorithms

- Understand details of Wireless network, Network architecture

- Able to evaluate communication networks using different performance parameter.

Section A

TCP/IP protocol: - Introduction to Computer Networks, Layered protocol, Network Interface, Internet Addressing, Subletting, mapping internet address to physical address, Internet Protocol, Routing algorithms (BGP), ICMP.

Transport Protocols: - UDP, TCP, TCP finite state machine implementation, SNMP.

Section B

ATM Networks: - ATM protocol stack, ATM switching, traffic management in ATM networks, Internetworking with ATM networks.

Wireless Networks: - Wireless channels, Channel Access, Network Architecture, Mobility management, WLAN. Introduction to internet telephone.

Section C

Performance evaluation of communication networks: Introduction to queuing theory, performance evaluation of ATM networks and wireless network.

IPV6 : Introduction, Type of services, Addressing scheme, Notation, Packet Format.

Suggested Books:

1 . Comer, D. E. (1995). Internetworking with TCP/IP, Vol. I: Principles, Protocols, and Architecture, 3/e. PHI

2. Walrand, J., & Varaiya, P. P. (2000). *High-performance communication networks*. Morgan Kaufmann.

3. Handel, R., Huber, M. N., & Schroder, S. (1998). *ATM networks: concepts, protocols, applications*. Addison-Wesley Longman Ltd..

4. Kasera, S. (2006). *ATM Networks Concepts and protocols*. Tata McGraw-Hill Education.

5. Stallings, W. (2002). *High-speed networks and internets: performance and quality of service*. Pearson Education India.

6. Tanenbaum, A. S. *Computer Networks* (3rd ed.). PHI Learning.

Suggested E-Resources:

1. TCP/IP and Advanced Topics

   https://www.coursera.org/learn/tcp-ip-advanced

2. Kurose, J. F., & Ross, K. W. (2009). *Computer networking: a top-down approach*. Boston: Addison Wesley.

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

CS 504 Advanced Java 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 advance concepts of Java like swings and RMI
- Able to develop complex application for networking.
- Design and develop JSP pages.
- Understand basics of AJAX,CORBA and EJB.

Section A

Java Script : Introduction to Java Scripts-Variables and Data Types. Statements and Operators. Control Structures, Functions, Dialog Boxes, Events, Event Handlers, Forms.

XML : Introduction to XML.

Swing : Introduction to Swing-Swing class heirarchy, Swing Components, Containers and Layout Managers.

Networking : Classes and Interfaces, Client-Server Architecture, Socket Overview, TCP/IP Sockets, Datagrams.

Section B

RMI : An Overview of RMI Applications, Remote Classes and Interfaces, RMI Architecture, Generating Stubs and Skeletons.

J2EE : Introduction to J2EE, J2EE Architecture, J3EE APLs, J3EE Containers, Installing and managing web server.

Servlets : Overview, Servlet Lifecycle, Generic Serlet, Servlet Request and Servlet Response, Http Servlet Request, Http Servlet Response and Http Servlet Request-response, handers, Session management and cookies.

Section C

JSP : Basics and Overview, JSP declaration, expressions, directives, Data Sharing among servlets & JSP, Request, application, session and page scope, JSP implict objects.

Beans : **Enterprise Java Beans :** Introduction, Types of EJB's, Elements of EJB's, EJB implicit objects.

Introduction to AJAX, CORBA, Hibernate, Struts, JSF.

Suggested Books:

1. Eckstein, R., Loy, M., & Wood, D. (1998). *Java swing*. O'Reilly & Associates, Inc..

2. Kumar, B. V. (2006). *J2EE architecture*. Tata McGraw-Hill Education.

3. Goodwill, J. (2001). *Developing java servlets*. Sams, Sams Techmedia.

4. Chopra,V. Eaves, J. Jones, J. *Beginning Java Server Pages*, Wrox Publication.

5. Farley, J., & Crawford, W. (2006). *Java Enterprise in a nutshell*. " O'Reilly Media, Inc.".

6. Schildt, H. (2007). *Java : The Complete Reference* (7th ed.). Tata McGraw-Hill .

7. Hunter, J., & Crawford, W. (2001). *Java Servlet Programming: Help for Server Side Java Developers*. " O'Reilly Media, Inc.".

8. Jaworski, J., & Jaworski, J. (1999). *Mastering JavaScript and Jscript*. .

9. Goodwill, J., & Hightower, R. (2004). *Professional jakarta struts*. John Wiley & Sons.

10. Crane, D., Bibeault, B., & Sonneveld, J. (2008). *Ajax in practice: das Praxisbuch für die Web 2.0-Entwicklung mit Frameworks*. Pearson Deutschland GmbH.

11. Harold, E. R. (2004). *Java network programming*. " O'Reilly Media, Inc."..

Suggested E-Resources:

1. W3Schools website

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

2. Java point website

   https://www.javatpoint.com/java-swing

CS 507 Artificial Intelligence

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 search, knowledge representation.
- Develop applications based on NLP Concepts
- Develop a Cognitive Agent

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, augumented 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

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

2. Artificial Intelligence: Principles and Techniques

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

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 of challenges 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 514 Computer Architecture and Organization

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.
- Be able to 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. Stallings, W. (2003). *Computer organization and architecture: designing for performance*. Pearson Education India.

    http://williamstallings.com/ComputerOrganization/

2. The Computing Technology Inside Your Smartphone

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

3. Computer Organizations and Architecture

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

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-Resources:

1. Data Mining

   https://nptel.ac.in/courses/106105174/

2. Business intelligence and data warehousing

   https://www.coursera.org/learn/business-intelligence-data-warehousing

Data Warehouse and Data Mining

S.No.	Problems	Topics to be covered
L1-L5	Introduction to the exploratory data analysis	Generate & load data, creating box plots, histograms,Scatter plots, Q-Q plots
L6-L10	Performing data preprocessing for data mining	Data cleaning. Integration & Transformation
L11-L13	Performing Association rule analysis	Apriori, FP Tree
L14-L16	Performing Classification	Decision Tree, Naive Bayes, Attribute Selection
L17-L18	Performing Clustering	K-means, Nearest Neighbor and Hierarchical
L19-L20	Performing Regression	Linear & Non Linear Regression

CS 526 Machine Translation

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 MT systems based on Example Based Approach.
- Develop Translation Memories.
- Develop basic transfer-based MT system
- Develop statistical MT system
- Develop Neural MT System

Section A

Computers in translation, history of machine translation, strategies for machine translation, direct, transfer based, example based and statistical, role of ai in machine translation, basic linguistics knowledge, formal background, character sets and typology, input methods, translator's workbench, translation memory, bilingual alignment, substantial alignment.

Section B

Computational morphology, syntactic analysis, parsing and generation, role of syntax, semantics and pragmatics in development of various types of machine translators, minimal recursion semantics, constraint systems, pos tagging, disambiguation of syntactic analysis, word sense disambiguation, transfer disambiguation.

Section C

Statistical Machine Transition, role of parameter estimation in machine transition, word based models, EM Algorithm, decoding process, phrase based models, Syntax based models, Statistical Phrase Based Transition, Syntax Based Statistical Transition Model, Clause Restructuring for SMT, evaluation of machine translation, evaluation strategies, quality measures, software evaluation, some popular evaluation metrics, future trends.

Suggested Books:

1. Trujillo, A. (2012). *Translation engines: techniques for machine translation*. Springer Science & Business Media.

2. Koehn, P.(2010), *Statistical Machine Translation*, Cambridge University Press.

3. Arnold, D. J., Balkan, L., Meijer, S., Humphreys, R. L., & Sadler, L. (1994). Machine Translation: an Introductory Guide. Blackwells-NCC, London. 1994.

4. Nirenburg, S., Somers, H. L., & Wilks, Y. (Eds.). (2003). *Readings in machine translation*. MIT Press.

5. Goutte, C., Cancedda, N., Dymetman, M., & Foster, G. (2009). *Learning machine translation*. Massachusetts Institute of Technology.

6. Wilks, Y. (Eds.). (2008), *Machine Translation: Its Scope and Limits,* Springer

Suggested E-Resources:

1. Arnold, D., Balkan, L., Meijer, S., Humphreys, R. L., & Sadler, L. (2001). *Machine Translation: An Introductory Guide.* Blackwell Publishers.

   http://promethee.philo.ulg.ac.be/engdep1/download/bacIII/Arnold%20et%20al%20Machine%20Translation.pdf

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 fundamentals of 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. (2003). *Mobile communications(2ed)*. Pearson education.

2. Stojmenovic, I. (Ed.). (2003). *Handbook of wireless networks and mobile computing* (Vol. 27). John Wiley & Sons.

3. Rappaport, T. S. (1996). *Wireless communications: principles and practice* (Vol. 2). New Jersey: prentice hall PTR.

4. Williams, V. (1995). *Wireless Computing Primer*. IDG Books Worldwide, Inc..

5. Pandya, R. (2001). *Mobile and personal communication systems and services*. PHI

6. Forman, G. H., & Zahorjan, J. (1994). The challenges of mobile computing. *Computer*, *27*(4), 38-47.

7. Hansmann, U., Merk, L., Nicklous, M. S., & Stober, T. (2013). *Pervasive computing handbook*. Springer Science & Business Media.

8. Perkins, C. E., Alpert, S. R., & Woolf, B. (1997). *Mobile IP; Design Principles and Practices*. Addison-Wesley Longman Publishing Co., Inc..

9. Garg, V. K., Smolik, K. F., & Wilkes, J. E. (1997). *Applications of CDMA in wireless/personal communications* (p. 54). NJ: Prentice Hall PTR.

10. Satyanarayan, M.,*Fundamental Challenges of Mobile Computing*.,Carnegie   Mellon University

11. Muller, N. J. (2001). *Bluetooth demystified* (Vol. 1). New York: McGraw-Hill.

12. Dhawan, C. (1997). *Mobile Computing*. McGraw-Hill Companies.

Suggested E-Resources:

1. Wireless Communications

   https://web.stanford.edu/class/ee359/

2. Data Communications II

   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, Linear 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
   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

    https://www.coursera.org/learn/language-processing

2. Natural Language Processing

    https://nptel.ac.in/courses/106101007/

.CS 530 Neural Networks

	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

- Understand need of Neural network along with its architecture.
- Develop neural network algorithms like back propagation etc.
- Learn concepts of learning models for different applications.

Section A

Introduction and ANN Structure: Biological neurons and artificial neurons, Model of an ANN, Activation functions used in ANNs, network architectures.

Mathematical Foundations and Learning mechanisms: Re-visiting vector and matrix algebra, State-space concepts, Concepts of optimization, Error-correction learning, Memory-based learning, Hebbian learning, Competitive learning; supervised, unsupervised and Reinforcement learning.

Single layer perceptrons: Structure and learning of perceptrons, Pattern classifier - introduction and Bayes' classifiers, Perceptron as a pattern classifier, Perceptron convergence, Limitations of a perceptrons.

Section B

Feedforward ANN: Structures of Multi-layer feed forward networks, Back propagation algorithm, Back propagation - training and convergence, Functional approximation with back propagation, Practical and design issues of back propagation learning.

Radial Basis Function Networks: Pattern separability and interpolation, Regularization Theory, Regularization and RBF networks, RBF network design and training, Approximation properties of RBF.

Recurrent Networks: Architectures, NARX, Back-propagation through time, Real-time recurrent learning.

Section C

Associative Networks: Auto-associative and Hetro-associative network, Bidirectional Associative memory network, Hopfield Network.

Competitive Learning and Self organizing ANN: General clustering procedures, Learning Vector Quantization (LVQ), Competitive learning

algorithms and architectures, Self organizing feature maps, Properties of feature maps.

Stochastic Model: Statistical mechanics, Simulated annealing, Boltzmann machine.

Suggested Books:

1. Haykin, S. (1994). *Neural networks: a comprehensive foundation*. Prentice Hall PTR.

2. Kumar, S. (2004). *Neural networks: a classroom approach*. Tata McGraw-Hill Education.

3. Demuth, H. B., Beale, M. H., De Jess, O., & Hagan, M. T. (2003). *Neural network design*. Thomson Learning,.

4. Freeman, J. A., & Skapura, D. M. Neural networks: algorithms, applications and programming techniques. 1991. *Reading, Massachussets: Addison-Wesley*.

Suggested E-Resources:

1. Introduction to Neural Networks

   http://www.cs.bham.ac.uk/~jxb/NN/

2. Neural Networks and Deep Learning

   https://www.coursera.org/learn/neural-networks-deep-learning

ELE 502   Discrete Time 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

- Understand Digital signal processing characteristics.
- Able to do transformation like FFT & DFT.
- Learn basic concepts of Multi rate Digital signal Processing.

Section A

General concepts of Digital processing: Typical Signal processing operation, example of typical signals, signal processing application basic elements of DSP, overview of DSP systems, Advantages and disadvantages of DSP.

Time domain Characteristic of Directed time System: Elementary sequences like unit sample, unit modulation ,addition, multiplication, delay and advance, Classification, of discrete time system in terms of linearity, time invariance, causality, stability and passivity; input output relationship and impulse response, response of LTI to any input, Convolution sum and its properties, Cascade and Parallel interconnection of LTI system, stability and response type of LTI system, constant coefficient difference equation for LTI system and its solution using homogenous and particular solution.

Section B

Transform domain analysis of LTI systems: Frequency response, frequency domain characterization of LTI system,transfer (Systems) function, derivation of transfer function (Using difference equation) interrelation, between frequencyresponse and transfer function of higher order filters (cascaded section) Comb filter, zero phase and linear phase FIR transfer functions, all pass transfer function and its properties, minimum phase transfer function, stability test using stability triangle, stability test procedure.

Discrete Fourier Transform : Review of discrete Fourier transfer, DFT as a linear transformation, circular shift and circular convolution of sequences, use of DFT in linear filtering of long data sequences, overlap-save and overlap method, add method, Goertzel and chirp z transform algorithms, radix 2 and radix 4 decimation in time and decimation in frequency FFT algorithm.

Section C

Structures for discrete time system : Basic building block of a discrete time system, pick off node, adder, multiplier, unit delay, structures for FIT systems, direct form, cascaded form frequency sampling and lattice transposed structures, cascade form, parallel form and lattice -ladder structure.

 Design of filters : Digital filter specification and selection, FIT filter

design using window (fixed and adjustable), frequency

sampling approach and Chebyshev approximation method : Design of IIR filter from analog filters using impulse invariance and Bi-linear transformation technique; Frequency transformation (to low-pass, high-pass, band-pass) in analog and digital domain.

Introduction to Multi-rate Digital Signal Processing : Needs of multi- rate DSP, Sampling rate conversion by a factor I/D Filter and implementation for sampling rate conversion of low-pass signals.

Suggested Books:

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. Discrete Time Signal Processing

   https://nptel.ac.in/courses/117105134/

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ELE 503 Embedded 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 architectural issues in embedded system
- Understand memory hierarchy in embedded system
- Able to connect embedded system in real life scenario like digital camera etc.

Section A

Introduction to embedded systems; design challenges: optimizing design metrics; processor technology - general purpose, single purpose and application-specific processors; architectural issues: risc, cisc and vliw architectures; custom single purpose processor design - combinational, sequential and rt-level components; design of controller and datapath using sequential program / fsmd; rt-level single-purpose processor design;

Optimizing custom single-purpose processors; application specific instruction set processors (asips) - microcontrollers, dsps; standard single - purpose processors: timers, counters, watchdog timers; uart, pwm, lcd controller, keypad controller, stepper motor controller, a2d converters, real time clocks.

Section B

Types of Memories for Embedded Systems; Component Interfacing: Interrupts, DMA, I/O Bus Structures, Communication Protocols; Introduction to IC Technologies : VLSI, ASIC and PLD IC Technologies; Basic Hardware and Software Tools for Embedded System Design: Linker, Loader, Assembler, Compiler, Simulator, Emulator, In System Programmer, Logic Analyzer etc.

Section C

Digital Camera Example for various Embedded System Implementations; Features of OS for Embedded Systems, Real Time Issues, Windows CE and QNX; Features of Languages for Embedded Systems Specification; Use of UML, Features and difference between VHDL, Verilog and SystemC; Introduction to Generic Co-design Methodology; Testing for Embedded Systems.

Suggested Books:

1. Berger, A. S. (2001). *Embedded systems design: an introduction to processes, tools, and techniques*. CRC Press.

2. Vahid, F., & Givargis, T. (2002). *Embedded system design: a unified hardware/software introduction* (Vol. 52). New York: Wiley.

3. Simon, D. E. (1999). *An embedded software primer* (Vol. 1). Addison-Wesley Professional.

4. Li, Q., & Yao, C. (2003). *Real-time concepts for embedded systems*. CRC Press.

5. Catroulis J(2003., *Designing Embedded Hardware*, O'Reilly Media,

6. Staunstrup J. ,Wolf W.(1997), *Hardware Software Co-Design: Principals and Practice*, Kluwar Academic Publishers,

7. Gajski, D. D., Vahid, F., Narayan, S., & Gong, J. (1994). Specification and design of embedded systems.

Suggested E-Resources:

1. Embedded Systems

   https://nptel.ac.in/courses/108102045/

ELE 505 Microprocessor and Microcomputer Applications

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

Learning outcomes:

On successful completion of the course students will be able to

- Learn basics of bus structure, timing and sequencing of microprocessor

- Understand microprocessor architecture and its basic components of 8086/8088.

- Able to write code using assembly programming.

Section A

Introduction : Microcomputers, Microprocessors, Bus structure of Microprocessor System. Microprocessor Architecture and Microcomputer systems : Microprocessor architecture & operation with example of 8085 Microprocessor, architecture, timing and sequencing, memory, I/O Memory and I/O synchronization, memory speed requirements, interfacing devices, logic levels, loading and buffering.

8085/8080-A Based Microcomputer systems : 8085 Microprocessor, Bus timings, Demultiplexing the Bus (AD7-AD8), Generating control signals, 8080 - A Microprocessor, Instructions and timing, instructions (8 bit & 16 bit), Data transfer operations, arithmetic operations, logic operations, Branch operations, counter & timing delays, stack & subroutines.

Section B

Interfacing peripherals, I/O, Memory and Applications: Interfacing output display, input keyboard, memory, memory mapped I/O, Interrupts and DMA : 8085/8080 - A interrupts structure types and masking, priority interrupt structure, real time clock and internal times, consideration for using interrupts, DMA & 8257 DMA controller. Programmable interface devices. Programmable peripheral devices. Parallel communication, 8255 Programmable Peripheral Interface, Serial Communication, RS-232-C interface, Data communication with TTY using SOD & SID lines.

Section C

Software model of the 8086/8088 microprocessor, Memory address space & data organisation, Segment registers & Memory segmentation, Dedicated & general use of memory, Instruction pointer, Data registers, Status

register, Generating a memory address, stack, I/O address space, Addressing modes of 8088. The 8086/8088 instruction set, Data transfer instructions, Arithmetic instructions, Logical instruction, Shift instructions, Rotate instructions, Flag control instructions, Compare instruction, Jump instructions, Subroutine & the subroutine handling instructions. Loop & loop handling instructions.

Suggested Books:

1. Pearson, R. S. G. P. H. (2002). *Microprocessor Architecture Programming and Applications with the 8085(5ed)* ,Penram International Publishing

2. Mathur, S. (2011). *Microprocessor 8086 and Architecture,Programming and Interfacing(2ed)*. PHI Learning Pvt. Ltd..

3. Short, K. L. (1987). *Microprocessors and programmed logic(2ed)*. Prentice-Hall, Inc..

4. Hall, D. V. (1986). *Microprocessors and interfacing(2ed),* McGraw-Hill, Inc..

5. Rafiquzzaman, M. (2008). *Microprocessor theory and applications with 68000/68020 and Pentium*. John Wiley & Sons.

6. Mathur, S. (2011). *Microprocessor 8085 and its interfacing*. PHI Learning Pvt. Ltd..

6. Mathivanan, N. (2003). *Microprocessors, PC Hardware and Interfacing*. PHI Learning Pvt. Ltd..

7. Kant, K. (2010). *Microprocessors and Microcontrollers:* PHI Learning Pvt. Ltd..

8. Liu, Y. C., & Gibson, G. A. (2011). *Microcomputer systems: the 8086/8088 family: architecture, programming, and design*. Englewood Cliffs: Prentice-Hall.

Suggested E-Resources:

1. Microprocessors And Microcontrollers
   https://nptel.ac.in/courses/108105102/59

IT 505 Geographic Information System

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 data models for GIS applications.
- Able to design & develop GIS applications using different GIS software
- Implement map projection on spatial data.

Section A

Introduction to GIS – definitions, concept and history, Hardware and software requirements in GIS, various elements of GIS. Concept of Layers and Coverages in GIS. Applications of GIS.

Introduction to map projections - Earth's shape and geodetic datums , Projection Types- Azimuthal, Cylindrical, Conic, Properties of map projections- Equal Area, Conformal, Distance, Common GIS Projections- Mercator, Lambert, Conformal Conic, State Plane, Lambert Equal Area, Map Scale, Tissot's Indicatrix

Co-ordinate system-overview, concept of latitude and longitude, Geographical and Projected Coordinate System, UTM

Data structures and formats, Spatial data models – Raster and Vector.

Data compression techniques – run length codes, quad trees.

Spatial data sources-Census and survey data, Aerial Photographs, Satellite images, GPS.

Section B

GIS Database Management Systems-Role in GIS, database creation, spatial and non-spatial data, Attribute Query, spatial query, GIS database applications.

Data input-analogue and digital data, methods-keyboard entry, digitizing-manual and automatic, electronic data transfer

Data editing-Detecting and Correcting errors, Re-projection, transformation and Generalization, Edge matching and rubber sheeting, Geocoding.

Data Quality and Output, Sources of Errors-errors in data encoding, editing and conversion, data processing and analysis, data output, Error modeling

Section C

Data analysis and modeling-Measurements, Queries, Reclassification.

Buffer analysis – its features, Overlay-vector and raster overlay, Spatial Interpolation,

Network Modeling and analysis-network elements, application context

Surface Modeling and Analysis-, Surface Significant Points.

Digital Elevation Models (DEM)-overview, structures and uses.

Overview of image processing & GIS packages.

Recent Trends in GIS – Virtual 3D GIS, Internet GIS, Open GIS.

GIS Case studies-Environment & facility management, Telecommunication, Water supply, Transportation

Suggested Books:

1. Ian, H. (2010). *An introduction to geographical information systems*. Pearson Education India.

2. Burrough, P. A.,(1988). *Principles of geographical information systems*. Oxford University Press.

3. Chang.T.K(2003)., *Geographic Information Systems(2ed).* Tata McGrawHill.

4. DeMers, M. N. (2005). *Fundamentals of geographic information systems*. John Wiley & Sons.

5. Lo, C. P., & Yeung, K. W. (2002). *Concepts and techniques of geographic information systems*, Prentice Hall.

6. Skidmore, A.(2002). *Environmental modelling with GIS and remote sensing*. Taylor and Francis.

7. Clarke K.C., Bradley O. P, Michael P. C.(2002), *Geographic Information Systems and Environmental Modeling*, Prentice-Hall,

8. Elangovan, K. (2006). *GIS: fundamentals, applications and implementations*. New India Publishing.

9. Ormsby, T., Napoleon, E., Burke, R., Groessl, C., & Feaster, L. (2004). *Getting to know ArcGIS desktop: basics of ArcView, ArcEditor, and ArcInfo*. ESRI, Inc..

Suggested E-Resources:

1. GIS in Civil Engineering
   https://nptel.ac.in/courses/105102015/

2. Geospatial Information and Services
   http://www.oc.nps.edu/oc2902w/gis/gisdemo/

IT 506 Human Computer Interaction

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 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.(2008) *Human-Computer Interaction(3ed)* , Pearson Education.

2. Caroll J.M., *Human-Computer Interaction in the new millennium*, Pearson,

Suggested E-Resources:

1. Human-Computer Interaction

   https://nptel.ac.in/courses/106103115/

2. Human Computer Interaction
   http://www.cs.ru.ac.za/courses/honours/HCI/lectures/lectureslides.php

IT 507 Information Retrieval

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 various IR concepts.

- Develop applications based on textual classification

- Create applications for Indian Language Information Retrieval Systems

Section A

Introduction, Building an inverted index, Processing Boolean Queries, Ranked Retrieval, Document delineation and character sequence decoding, determining vocabulary of terms, Positional posting and phrase queries, dictionary retrieval, Index construction, various types of indexing techniques, Parametric and zone indexing, term frequency and weighting, vector space model for scoring.

Section B

Efficient scoring and ranking, Tiered indexes, Query term proximity, designing parsing and scoring functions, vector space scoring and query operator interactions, IR system evaluation, Evaluation of ranked and unranked result sets, assessing relevance, Relevance feedback, global methods for query reformulation.

Section C

Bayesian Text Classification Model, Vector Space Classification, KNN classifier, Linear classifiers, classification of documents using SVM Model, machine learning methods in adhoc IR, Clustering in IR, evaluation of clustering, k-means, model based clustering, hierarchal clustering, Web search basics, Web crawling and indexes, link analysis, page rank algorithms, information extraction, sentiment analysis and opinion mining, social network analysis.

Suggested Books:

1. Manning, Christopher D., Raghavan Prabhakar, Schütze Hinrich(2008), Introduction to Information Retrieval, Cambridge University Press..

2. Baeza-Yates, R., & Ribeiro, B. D. A. N. (1999). *Modern information retrieval(1ed).* Pearson Education Limited

3. Grossman, D. A., & Frieder, O. (2004). *Information retrieval: Algorithms and heuristics* (2ed)). . Netherlands: Springer

4. Van Rijsbergen, C. J. (2004). *The geometry of information retrieval*. Cambridge University Press.

5. Manning, C. D., Manning, C. D., & Schütze, H. (1999). *Foundations of statistical natural language processing*. MIT press.

6. Jurafsky, D., & Martin, J. H. (2008). *Speech and language processing* (2ed). Pearson Education.

Suggested E-Resources:

1. Schütze, H., Manning, C. D., & Raghavan, P. (2008). *Introduction to information retrieval*. Cambridge University Press.

   https://nlp.stanford.edu/IR-book/newslides.html

2. Information Retrieval and Web Search

   https://www.cs.utexas.edu/~mooney/ir-course/

IT 511 System Testing

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 different types of testing methods.
- Able to solve testing problems in software projects.
- Learn importance of documentation in testing.

.Section A

Introduction to Software testing, Error fault, Failure, Incident, Test cases, Test Plan, Software testing processes overview, Incremental testing approach, Test outlines, Limitation of Testing.

Section B

Functional Testing: Boundary value analysis, Equivalence Class Testing, Decision Table Based Testing and cause effect - graphing Technique, Structural Testing: Path Testing, Cyclomatic Complexity, Graph metrics, Data Flow testing, Mutation Testing. Object Oriented Testing: Issues, Class Testing, GUI Testing, Object Oriented Integration and System testing, Testing Web Based Systems

Section C

Reducing the number of test cases : Prioritization guidelines, Priority category scheme, Risk analysis, Regression Testing, slice based Testing,

Testing activities : Unit Testing, Levels of Testing, and Integration Testing, System Testing, Debugging, Domain Testing, Testing Tools: Static Testing Tools, Dynamic testing Tools, and characteristics of Modern Tools.

Building and applying standards to test Documentation : Configuration management, Reviews, Industry Standards - ISO 9001, CMM for Software, IEEE standards.

Suggested Books:

1. Tamres L(2002), *Introducing Software Testing(2ed)*, Pearson Education.
2. William P.(2006), *Effective Methods for Software Testing*(3ed), Wiley India.
3. Beizer B(2003), *Software Testing Techniques*(2ed), Dream Tech Press.
4. Singh,Y. *Software Testing* : Cambridge University Press.

5. Pressman, R. S. (1997). *Software Engineering: a practitioner's approach* (4th ed.). Tata McGraw-Hill.

6. Aggarwal K.K & Singh Y.(2008), *Software Engineering(3ed)*, New Age International Publishers.

3. Mathur, A.P. (2001), *Foundations of software testing*, Pearson Education.

4. Patton R.(2000), *Software Testing*, Techmedia.

5. Jorgensen, P.C.(2008), *Software Testing a Craftsman Approach*, Auerbach blisher.

Suggested E-Resources:

1. Software Testing

   https://nptel.ac.in/courses/106105150/

2. Software Testing

   https://www.coursera.org/lecture/software-processes/software-testing-introduction-XmIRH

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

IT 412   Internet of Things

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

Learning Outcomes:

On successful completion of the course, the student will:

- Understand the concept of IoT
- Understand what constitutes an IoT design solution
- Identify the sensors and basic electronic design needed for different IoT solutions
- Analyze basic proptocols of IoT
- Implement basic IoT applications on Arduino and Raspberry Pi to provide IoT solutions for various domains.

Section A

Introduction of IoT, M2M (Machine-to-Machine) towards IoT-the global context, Differing Characteristics.

M2M to IoT – Introduction, Some Definitions, industrial structure for IoT, architecture for conversion of **M2M to IoT**, design principles ,capabilities of IoT, IoT architecture , standard protocol, **IoT Architecture Reference Model,** Functional View, Information View, Deployment and Operational View, Domain specific applications of IoT: Home automation, Industrial applications, Surveillance applications, Other IoT applications.

Section B

Introduction to concept of IoT devices, IoT devices versus computers, IoT configurations, basic components, networking, sensors, introduction to embedded   systems
Introduction to Arduino, types of Arduino, Arduino toolchain, Arduino programming structure, Sketches, Pins, Input-output from pins using sketches, Introduction to Arduino shields, Introduction to Raspberry-Pi microcomputer Accessing GPIO pins, Sending and receiving signals using GPIO pins

Section C

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT,Security in IoT protocols.

Suggested Books:

- Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

- Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014.

- Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013

Suggested E-resources:

https://onlinecourses.nptel.ac.in/noc19_cs31

https://www.edx.org/course/introduction-to-the-internet-of-things-iot-1

https://www.edx.org/course/sensors-and-devices-in-the-iot

https://www.edx.org/course/iot-networks-and-protocols

https://alison.com/course/internet-of-things-and-the-cloud

https://online.stanford.edu/courses/xee100-introduction-internet-things

Reading Elective

IT   402R   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.

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

- To make students able to learn fundamental concepts of ERP system and ERP related technologies.

- To 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, MRP-II, MR.P-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 and related 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, JIT & 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 (E1A); 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.

IT   604R   Semantic Web

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 role of semantic web in real world applications.
- Develop knowledge implementation in different domains
- Learn different types of ontologies.

Section A

Introduction to Semantic Web: History of the (Semantic) Web, Vision of Next Generation Web Technology, Semantic Web Services and Challenges, life cycle of Semantic web, difference between syntactic and semantic web.

Section B

Ontology: Origins and history. Ontologies and schema languages on the web-Introduction to Ontology Development, elements of Ontology, development methodologies, languages of Ontology, types of Ontologies, Ontology Acquisition with Examples.

Section C

Static and dynamic Semantics of the web - Sources of dynamic semantics Information retrieval and theorem-Proving perspectives, Semantic web enabled web services, Applications of Semantic web.

Suggested Books:

1. Akerkar, R. (2009). *Foundations of the semantic Web*, Narosa Publishing House
2 Hitzler, P., Krotzsch, M., & Rudolph, S. (2009). *Foundations of semantic web technologies*. Chapman and Hall/CRC.
3. Fensel, D.,Hendler,J.Henry,L.,&Wolfgang,W.(2005). *Spinning   the Semantic Web,*. Mit Press.

IT 601R Information and Communication Technology

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 importance of ICT and its various components.

- Learn about different types of Network & internet terminologies.

- Able to understand the usability of human computer interaction.

Section A

Information Technology:

IT Infrastructure : Basics, Infrastructure Components, Contemporary Hardware Platform Trends,

Managing Data Resources: Traditional File Environment, Database Approach,

Introduction to DBMS, Introduction to ERP, current trends in DBMS and ERP, MIS : Introduction, structure, current trends

Section B

Communication Technology : Introduction to telecommunication. Networks, Intranet and the Internet, Networking Infrastructure, Technologies and Tools for communication and E-Commerce, Wireless computer Networks and Internet Access(with example Bluetooth, Wi-Fi, WiMax and EV-DO)Technologies and Tools for Security and Control

Section C

Human Computer Interaction (HCI) :

HCI and interactive system design from an ICT perspective, psychological issues in HCI, Issues for interactive system design and the ICT context (social and organizational interactivity), tools and techniques for interaction design, user centered design, prototype and evaluation

Suggested Books:

1. Laudon, K. C., & Laudon, J. P. (2016). *Management information system*. Pearson Education India.

2. Preece, J., Rogers, Y., & Sharp, H. (2015). *Interaction design: beyond human-computer interaction*. John Wiley & Sons.

3. Dix A., Finlay J. et al.. *Human Computer Interaction,* Pearson LPE

4. Connolly M.T., Begg E.C.; *Database Systems : A Practical Approach to Design, Implementation and Management*, Addison-Wesley Publication

5. Comer D.E*., ComputerNetworks and Internets(5ed)*, PHI publication

6. McLeod, R., & Schell, G. P. (2007). *Management information systems*. Pearson/Prentice Hall.

7. Jawadekar, W. S. (2013). *Management Information Systems: Text and Cases: a Global Digital Enterprise Perspective*. Tata McGraw-Hill Education.

Online Reading Electives

Machine Learning

	L	T	P	C
	0	0	0	2

https://www.coursera.org/learn/practical-machine-learning

Johns Hopkins University

Learning Outcomes:

On successful completion of the course, the student will:

- Understand Machine Learning Techniques
- Design Basic Practical Applications
- Understand Model Based Prediction

Brief description

One of the most common tasks performed by data scientists and data analysts are prediction and machine learning. This course will cover the basic components of building and applying prediction functions with an emphasis on practical applications. The course will provide basic grounding in concepts such as training and tests sets, overfitting, and error rates. The course will cover the complete process of building prediction functions including data collection, feature creation, algorithms, and evaluation.

Brief Course outline

- Prediction, relative importance of steps, errors, and cross validation
- The Caret package, tools for creating features and pre-processing
- Predicting with trees, RandomForests, & Model Based Predictions
- Regularized Regression and Combining Predictors

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

Blockchain

	L	T	P	C
	0	0	0	2

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 blockchain programming, which is the focus of two subsequent specialization courses, Smart Contracts and Decentralized Applications (Dapps).

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