UNIVERSITY OF MUMBAI

No.UG/ICD/147 of 2018-19
Mumbai-400 032
14th March, 2019

To,
The Co-ordinator,
School of Engineering Science,
Kalyan Sub - Centre,
Gandhar Nagar,
Khadakpada,
Kalyan (West),
Pin code – 421 301.

Sir,

I am to invite your attention to the Ordinances, Regulations and Syllabus relating to the M.Tech. (Computer Engineering) and to inform you that the proposed syllabus made by the Co-Dean, Faculty of Science and Technology, have been accepted by the Academic Council at its meeting held on 30th July, 2017 **vide** item No. 4.10 and subsequently approved by the Management Council at its meeting held on 28th November, 2017 **vide** item No.03 and that in accordance therewith, in exercise of the powers conferred upon the Management Council under Section 74 (4) of the Maharashtra Public Universities Act, 2016 (Mah. Act No. VI of 2017) the Ordinances 6446 & 6447 Regulations 9173 & 9174 and the syllabus as per (CBCGS) for the M.Tech. (Computer Engineering) has been newly introduced course as per appendix and the same have been brought into force with effect from the academic year **2017-18**, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
14th March, 2019

(Dr. Ajay Deshmukh)
REGISTRAR

A.C/4.10/30.07.2017
M.C/03/28.11.2017

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No. UG/147 -A of 2018-19 MUMBAI-400 032 14th March, 2019

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Director, Board of Examinations and Evaluation,
3) The Director, Board of Students Development,
4) The Co-ordinator, University Computerization Centre,

(Dr. Ajay Deshmukh)
REGISTRAR

AC- 30/07/2017
Item No. – 4.10

UNIVERSITY OF MUMBAI

Proposal for Starting a New Program

School of Engineering Science

at

University of Mumbai, Kalyan Sub-Center

From

Academic Year 2017-18

AC- 30/07/2017

Item No. – 4.10

Proposal for starting School of Engineering Science at University of Mumbai, Kalan Sub center.

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Item No. – 4.10

I. Proposal Summary

1. Proposed by: Faculty of Technology, University of Mumbai.
2. Program : School of Engineering Science
3. Course Name: M. Tech.(Computer Engineering)
4. Course Level/Duration: Post Graduate – Two years
5. Course Name: M. Tech.(Computer Engineering)
6. Proposed Start Date: Academic Year 2016-17 - August: 2016.
7. Proposed Strength: 30 students
8. No. of Batches: One
9. Eligibility for admission:
    i. Candidate should have passed B. E./B. Tech. Degree in branch of Computer Engineering , Information Technology, Electronics Engineering, Electronics and Telecommunication Engineering, Electrical Engineering, Instrumentation Engineering.
    ii. Valid Gate score
10. Structure Course Curriculum: Separately attached. (Annexure A)

II. Background

University of Mumbai carved out in 156 years of its functioning attests to its manifold achievements as the intellectual and moral powerhouse of the society. The University has always given its best to the country in general and to the city of Mumbai in particular by enthusiastically shouldering an ever-growing load of social values and opportunities.

Initially, the University concentrated its efforts on controlling teaching at the undergraduate level and in conducting examinations. Later on it took up research and the task of imparting

instructions at the Post-Graduate level. This resulted in the establishment of the University Departments beginning with the School of Sociology and Civics & Politics. The independence of the country led to the re-organization of the functions and powers of the University with the passing of the Bombay University Act of 1953.

It has two campuses of areas 243 acres and 14 acres at Vidyanagari and Fort respectively; sub-campuses/centers at Ratnagiri 20 acres, Thane 6.50 acres and Kalyan 6.26 acres with 60 University Departments & Institutes and 749 affiliated colleges. It has established its name in industrial & International collaborations and runs various professional courses.

At national level, it has excelled in sports, cultural and out-reach activities. In the last five years it has seen 104% increase in under-graduate students, 112% increase in post-graduate students and 147% increase in distance - education students. There is 156% increase in the number of research papers published in International journals. Twelve Department/sections are recognized under various national programmes, such as SAP/CAS/DRS/DSA/COSIST/FIST. More than eighty teachers are on various professional bodies. Eighteen National/International awards are won by teachers in the last five years. Every year about 20 teachers visit abroad for academic activities. Recently more than ten self-supporting courses have been started by the University.

Kalan - Dombvali Municipal Corporation is sponsored the proposal for starting School of Engineering Science at University of Mumbai, Kalan Sub center.

III. Need for a Focused and Dedicated Program

- Efficient and resource –optimal computing is extremely important in today's world. There is increased need for advancement in computer architecture and integration of computer hardware, software, algorithms and data management techniques. The advanced knowledge of these aspects enhances career prospects in computing. M Tech in Computer Engineering is intended to train the students in advanced areas in the core courses and specialized areas in Computer Engineering.
- The objective of this program is industry-relevant curriculum and train the manpower required to meet the industry needs. The curriculum is aimed at giving strong theoretical foundation and hands-on exposure in Advanced Operating Systems, Embedded System Design, Cloud Computing, Big Data, Distributed Computing and Image Processing.
- The mandatory project work empowers the students to gain in-depth knowledge.

IV. Important objectives of the new program –

1. Graduate of Program will have successful technical and professional career.
2. Graduate will be competent in technical skills to cater the needs of the local industry, academic institutes, R& D institutions, administration, entrepreneurship, leadership for the overall up liftment of society.
3. Graduate of Program will be able to analyze real life problems, design computing systems appropriate to its solutions that are technically sound, economically feasible and socially acceptable.

4. Graduate will exhibit professionalism, ethical attitude, communication skills, team work in their profession and adapt to current trends by engaging in lifelong learning.

V. Curriculum Design and Teaching Methodology

1. Course curriculum for the new program should been designed as per choice based credit system.
2. Course curriculum for the new program has been designed to meet the course objectives. The quality standard of the curriculum is slightly higher than the other M. Tech. programs keeping in mind the high standards demanded by the global companies and hence provides higher career placement potential.
3. The subjects chosen are based on its' requirements in industry rather than crowding the curriculum with too many specialized subjects.
4. Syllabus content has been decided duly considering its utility value for industry/business application.
5. The emphasis is on the quality of the syllabus content and not on exhaustive coverage of the topic.
6. Teaching methods for the program will be combination of conceptual lectures, case study analysis and Practical or hands on projects. On campus training followed by on the industry internship are intended to augment the application capability of the students.
7. Curriculum includes training in relevant areas of information technology, Research work and communication/Presentation Skills.
8. The quality of examinations would match with University standards and prescribes a higher minimum score for pass; to call for more directed efforts on the part of the students.

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VI. Resource need for new M.Tech Program

1. Faculty/ Staff Resources:

M.Tech. in Computer Engineering is has organized itself in to a full fledge program with a Director (Coordinator) and dedicated two of faculty members as well as qualified professionals on visiting basis from the Industry.

Sr. No	Post	Qualification	Number of post
1	Director (Professor)	PhD in Computer Engineering having min. 13 yrs. Experience.	1
2	Associate Prof.	PhD in Computer Engineering having min. 10 yrs. Experience.	1
3	Asst. Professor	MTech/ ME in Computer Engineering having 5 yrs. Experience.	1
4	Clerk	Any Graduate	1

2. Laboratory:

- For M.Tech. in Computer Engineering one Laboratory having 30 computers with latest configuration is required.
- Laboratory should connect in LAN as well as min.10 Mbps internet connection.
- One printer and one scanner.

3. Classroom & tutorial room

- One class room of 60 sqm.
- One office of 60 sqm.
- One Director/ Coordinator of 20 sqm
- Faculty room of 20 sqm

VII. Budget :

1. Revenue:

First Year M. Tech Tuition Fee Rs. 61000/- per student

Intake : 30

Total Revenue for First year M Tech.: Rs 18,30000/-

2. Expenditure

Sr. No.	Item	Quantity	Cost per Item (Rs)	Total Cost (Rs)
1	COMPUTERS ---------- (Intel P-Iv, 2.8 Dual Core Cpu 2180@ 2.8 Ghz ,M/B Intel G31gl ,Ddr2 Ram 4 Gb,Software(02 Ss & 01 App) ---------- a. 30 For Lab, b. 02 for office c. 02 for Faculty d. 01 for Director	35	30000	1050000
2	COMPUTER TABLE	35	3000	105000
3	PRINTER	02	7000	14000
4	SCANNER	01	5000	5000
5	UPS	01	10000	10000
6	INTERNET (10 MBPS)	1:1	15000	15000
7	LAN CONNECTION	--	10000	10000
8	FULL TIME DIRECTOR/ COORDINATOR	1	Rs 1.40 Lakh per month	1680000
9	VISITING FACULTY	75 credit	Rs.1000 per hr	75000
10	CLERK	1	Rs 15000	180000
Total Cost				**31,44000/-**

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VIII. Structure Course Curriculum:

Program Structure for M. Tech. (Computer Engineering) at University Campus

Semester-I

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	TW/	Total
MTech-CEC101	Core Course-1	4	-	4	--	4
MTech-CEC102	Core Course-2	4	-	4	--	4
MTech-CEC103	Core Course-3	4	-	4	--	4
MTech-CEDEC-I	Department Elective Course-I	4	-	4	-	4
MTech-CEIEC-I	Institute Elective Course-I	4	--	4	--	4
MTech-CEL101	Laboratory-I	--	2	-	1	1
MTech-CEL102	Laboratory-II	-	2	-	1	1
	Total	**20**	**04**	**20**	**02**	**22**

Semester-II

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	TW/ Pract	Total
MTech-CEC201	Core Course-4	4	-	4	--	4
MTech-CEC202	Core Course-5	4	-	4	--	4
MTech-CEC203	Core Course-6	4	-	4	--	4
MTech CEDEC-II	Department Elective Course-II	4	-	4	-	4
MTech-CEIEC-II	Institute Elective Course-II	4	--	4	--	4
MTech-CEL201	Laboratory-III	--	2	-	1	1
MTech-CEL202	Laboratory-IV	-	2	-	1	1
	Total	**20**	**04**	**20**	**02**	**22**

 # Departmental Elective Course (DEC) Every student is required to take one department Elective course for semester-I and semester-II and different sets of courses will run in the both the semesters. Students can take those courses in the list of department Electives, which are closely allied to their disciplines.

 # Institute Elective Course (IEC): Every student is required to take one Institute Elective course for semester-I and semester-II which are not closely allied to their disciplines and different sets of courses will run in the both the semesters.

Semester-III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract /Pract	Total
MTech-CE301	Special topic seminar	--	06	--	3	3
MTech-CE302	Dissertation -I	--	24	--	12	12
	Total	**--**	**30**	**--**	**15**	**15**

Semester-IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
MTech-CE401	Dissertation -II	--	30	--	15	15
	Total	**--**	**30**	**--**	**15**	**15**

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UNIVERSITY OF MUMBAI

School of Engineering Science, Kalyan Sub-Center

Rules and Regulations

for

M. Tech. (Computer Engineering)

Course Introduced from A. Y. 2017-18 onwards

AC- 30/07/2017

Item No. – 4.10

Preamble

M. Tech. in Computer Engineering programme is offered to students who are interested in advanced learning and research in any area of Computer Science and Engineering. Applicants to this programme are expected to have a background in Computer Science and Engineering or Information Technology.

The objective of the programme is to enable the learner to apply his/her enhanced skill and knowledge at the top research laboratories and companies in the country and even abroad.

The programme is a 72-credit degree programme, which is usually spread over 4 semesters for a full-time student. About two-thirds of the credits involve coursework, and the remaining consists of project work. The emphasis is on conducting original research and writing a thesis individually. The programme is flexible enough to allow a student to specialize in any topic of interest by taking elective (optional) courses and working on a research project in that area.

University of Mumbai feels that it is desirable to provide specialized M. Tech. programme in Computer Engineering to address the needs of the industry, which today requires more specialized resource in each field.

School of Engineering Science, University of Mumbai, Kalan Sub center has taken a lead in incorporating philosophy of Choice Based Education in the process of curriculum development.

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Item No. – 4.10

1. Introduction

University of Mumbai carved out in 156 years of its functioning attests to its manifold achievements as the intellectual and moral powerhouse of the society. The University has always given its best to the country in general and to the city of Mumbai in particular by enthusiastically shouldering an ever-growing load of social values and opportunities.

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At national level, it has excelled in sports, cultural and out-reach activities. In the last five years it has seen 104% increase in under-graduate students, 112% increase in post-graduate students and 147% increase in distance - education students. There is 156% increase in the number of research papers published in International journals. Twelve Department/sections are recognized under various national programmes, such as SAP/CAS/DRS/DSA/COSIST/FIST. More than eighty teachers are on various professional bodies. Eighteen National/International awards are won by teachers in the last five years. Every year about 20 teachers visit abroad for academic activities. Recently more than ten self-supporting courses have been started by the University.

Kalan - Dombvali Municipal Corporation is sponsored the proposal for starting School of Engineering Science at University of Mumbai, Kalan Sub center.

2. Admission Process

School of Engineering Science, University of Mumbai, has been offering post-graduate programs leading to Master's degree in Technology (M.Tech.) since 2017-18.

Admissions to this program are based on primarily on the valid GATE (Graduate Aptitude Test Examination) score as per the norms set by the DTE.

M. Tech. eligibility criteria

Candidates seeking admission to Maharashtra M.Tech. programme will have to fulfill the eligibility criteria set by Directorate of Technical Education (DTE), Maharashtra, to be considered for admission. The important eligibility criteria for admission are given below:

- The candidate needs be an Indian National.
- Hold a Bachelor's degree in the relevant field of Engineering/Technology from an All India Council for Technical Education or Central or State Government approved institution or its equivalent with minimum 50% marks (45% in case of candidates belonging to backward class categories and persons with disability and belonging to the State of Maharashtra).
- Passed Bachelor Degree in the relevant field of Engineering and Technology as per the DTE eligibility criteria for admission to the Post Graduate course the candidate is seeking admission to.
- Must have obtained a positive (non-zero) score in GATE.

3. Intake

The intake for the M. Tech. (Computer Engineering) program is 30 and reservation as per norms DTE and State of Maharashtra.

4. Fees:

5. Attendances

- Attendance in classes for all the subjects is compulsory and should be 100%.
- Relaxation of maximum 25% in attendance is permissible to the students on account of medical problems or any genuine reason.
- Student not having 75% attendance in any course/ practical will not be allowed to appear in the end-term examination of that respective course/ practical and given XX grade. He/she has to reregister for all such courses.

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UNIVERSITY OF MUMBAI

Syllabus for M. Tech. (Computer Engineering)

School of Engineering Science, Kalan Sub-Center

(As per Choice Based Credit and Grading System)

from

Academic Year 2017-18

AC- 30/07/2017

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From Co-ordinator's Desk:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

AC- 30/07/2017

Item No. – 4.10

Preamble:

The M. Tech. in Computer Engineering programme is offered to students who are interested in advanced learning and research in any area of Computer Science and Engineering. Applicants to this programme are expected to have a background in Computer Science and Engineering or Information Technology.

The objective of the programme is to enable the learner to apply his/her enhanced skill and knowledge at the top research laboratories and companies in the country and even abroad.

The programme is a 74-credit degree programme, which is usually spread over 4 semesters for a full-time student. About two-thirds of the credits involve coursework, and the remaining consists of project work. The emphasis is on conducting original research and writing a thesis individually. The programme is flexible enough to allow a student to specialize in any topic of interest by taking elective (optional) courses and working on a research project in that area.

University of Mumbai feels that it is desirable to provide specialized M. Tech. programme in Computer Engineering to address the needs of the industry, which today requires more specialized resource in each field.

Faculty of Technology, University of Mumbai has taken a lead in incorporating philosophy of Choice Based Education in the process of curriculum development.

Dr. Subhash K. Shinde

Chairperson,

Adhoc Board of Studies in Computer Engineering,

University of Mumbai, Mumbai.

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Program Structure for M. Tech. in Computer Engineering,

University of Mumbai)

Semester –I

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC101	Algorithm & Complexity	04	---	---	04	---	---	04
CSC102	Advance Computer Network and Design	04	---	---	04	---	---	04
CSC103	Advanced Operating Systems	04	---	---	04	---	---	04
CSEL-I	Elective-I	04	---	---	04	---	---	04
CSEL-II	Elective-II	04	---	---	04	---	---	04
CSL101	Lab-I: Computational Laboratory on Core Courses	--	02	--	01	---	--	01
CSL102	Lab-II :Laboratory on Elective Courses	--	02	--	01	---	--	01
Total		20	04	--	22	--	--	22

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC101	Algorithm & Complexity	20	20	20	80	3	--	---	100
CSC102	Advance Computer Network and Design	20	20	20	80	3	--	---	100
CSC103	Advanced Operating Systems	20	20	20	80	3	--	---	100
CSEL-I	Elective-I	20	20	20	80	3	--	---	100
CSEL-II	Elective-II	20	20	20	80	3	--	---	100
CSL101	Lab-I: Computational Laboratory on Core Courses	---	---	---	----	----	25	25	50
CSL102	Lab-II :Laboratory on Elective Courses	---	---	---	----	----	25	25	50
Total		100	100	100	400	----	50	50	600

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Program Structure for M. Tech. in Computer Engineering, University of Mumbai

Semester –II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS201	High performance Computing	04	---	---	04	---	---	04
CS202	Data Science	04	---	---	04	---	---	04
CS203	Ethical Hacking and Digital Forensics	04	---	---	04	---	---	04
CSEL-III	Elective-III	04	---	---	04	---	---	04
CSEL-IV	Elective-IV	04	---	---	04	---	---	03
CSL201	Lab-III: Computational Laboratory on Core Courses	--	02	--	01	---	--	01
CSL202	Lab-IV: Laboratory on Elective Courses	--	02	--	01	---	--	01
Total		20	04	---	22	--	--	22

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC201	High performance Computing	20	20	20	80	3	--	---	100
CSC202	Data Science	20	20	20	80	3	--	---	100
CSC203	Ethical Hacking and Digital Forensics	20	20	20	80	3	--	---	100
CSEL-III	Elective-III	20	20	20	80	3	--	---	100
CSEL-IV	Elective-IV	20	20	20	80	3	--	---	100
CSL201	Lab-III: Computational Laboratory on Core Courses	---	---	---	---	----	25	25	50
CSL202	Lab-IV :Laboratory on Elective Courses	---	---	---	---	----	25	25	50
		100	100	100	400	----	50	50	600

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Program Structure for M. Tech. in Computer Engineering,

University of Mumbai

Semester –I

Course Code	Elective - I	Course Code	Elective -II
CSE1011	Logic & Automated Reasoning	CSE1021	User Experience Design
CSE1012	Image Analysis & Interpretation	CSE1022	Mobile & Adaptive System
CSE1013	Natural Language Processing	CSE1023	Advanced Network Programming
CSE1014	Computational Intelligence	CSE1024	Operations Research

Semester –II

Course Code	Elective -III	Course Code	Elective -IV
CSE2031	Data Storage & Retrieval	CSE2041	ICT for Social cause
CSE2032	Internet of Things	CSE2042	Internet Routing Design
CSE2033	Advance Soft Computing	CSE2043	Grid and Cloud Computing
CSE2034	Semantic Web & Social Network Analysis	CSE2044	Project Management

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Program Structure for M. Tech. in Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS301	Special Topic Seminar	----	06	--	---	03	--	03
CS302	Dissertation-I	---	24	--	---	12	--	12
Total		**----**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CS301	Special Topic Seminar	---	---	---	---	---	50	50	100
CS302	Dissertation-I	---	---	---	---	---	100	---	100
Total		---	---	---	----	---	**150**	**50**	**200**

Semester –IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS401	Dissertation-II	--	30	--	---	15	--	15
Total		**--**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in			
		Test 1	Test 2	Avg.					
CS401	Dissertation-II	--	---	---	---	---	100	100	200

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Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC101	Algorithm and Complexity	04	--	--	04	--	--	04
		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	Term Work	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--
Total		--	---	---	---	---	**100**	**100**	**200**

Course Objectives:

1. To analyze the algorithms using space and time complexity.
2. To teach problem formulation and problem solving skills.
3. To acquire knowledge of various applied algorithms.
4. To understand selected topics in algorithms that have found applications in areas such as geometric modelling, graphics, robotics, vision, computer animation, etc.

Course Outcomes: At the end of the course student should be

- Able to prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains
- Able to apply the algorithms and design techniques to solve problems.

Prerequisite: Data structure, Analysis of Algorithms, Set Theory

Sr. No.	Module	Detailed Content	Hours
1	Foundations	• Algorithms, Analysing algorithms, Growth of Functions-Asymptotic notation, Mathematical Background for algorithm analysis • Recurrences, The substitution method, The recursion-tree method, The master method, Randomized algorithms	4
2	Advanced Design and Analysis Techniques	• Dynamic Programming-Elements of dynamic programming, Matrix-chain multiplication • Greedy Algorithms-Elements of the greedy strategy, Huffman codes • Amortized Analysis-Aggregate analysis, The accounting method, The potential method, Dynamic tables	6

3	Graph Algorithms	• Single-Source Shortest Paths-The Bellman-Ford algorithm, Dijkstra's algorithm, Difference constraints and shortest paths • All-Pairs Shortest Paths-The Floyd-Warshall algorithm • Maximum Flow-Flow networks, The Ford-Fulkerson method, Maximum bipartite matching	8
4	Computational Geometry	• Line-segment properties, Determining whether any pair of segments intersects, • Finding the convex hull, Finding the closest pair of points	8
5	NPC and Approximation Algorithms	• NP-Completeness: NP-completeness and reducibility, NP-completeness proofs, NP-complete problems, • Approximation algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, The subset-sum problem	10
6	Applied Algorithms	• Number-Theoretic : Number Theoretic notion, Greatest common divisor, The Chinese remainder theorem, RSA • String Matching Algorithms :The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm, Longest common subsequence • Parallel Algorithm: Mesh Algorithm and its applications • Probabilistic Algorithm: Game Theoretic Techniques • Randomized Algorithms: Monte Corlo and Las Vegas algorithms	12

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", PHI, India Second Edition
2. Horowitz, Sahani and Rajsekaran, Fundamentals of Computer Algorithms", Galgotia
3. Rajeev Motwani, PrabhakarRaghavan, " Randomized Algorithm", Cambridge University Press

Reference Books:

1. Aho, Hopcroft, Ullman: The Design and analysis of algorithms", Pearson Education
2. Vijay V. Vajirani, "Approximation Algorithms",Springer.

3. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI
4. SanjoyDasgupta, Christos Papadimitriou, UmeshVazirani, "Algorithms", Tata McGraw-Hill Edition

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

AC- 30/07/2017

Item No. – 4.10

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC102	Advanced Computer Networking and Design	04	--	--	04	--	--	04
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To study the problem of congestion control and service integration in TCP/IP networks focusing on protocol design, implementation and performance issues.
2. To understand the principles of network design and enable students to setup, configure and interconnect an IP network.
3. To debate the current trends and leading research in the computer networking area.

Course Outcomes: Learner will able to

- Understand the theoretical issues in protocol design and apply it to Quality of service in networks.
- Understand issues in the design of network processors and apply them to design network systems
- Simulate working of wired and wireless networks to understand networking concepts.
- Develop solutions by applying knowledge of mathematics, probability, and statistics to network design problems.
- Understand the basics of software defined networking and explore research problems in that area.

Sr. No.	Module	Detailed content	Hours
1	**Internetworking**	**Congestion control and Resource allocation**: Issues of Resource Allocation, Queuing Disciplines: FIFO, Fair Queuing, TCP Congestion Control: Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery. **Congestion-Avoidance Mechanisms**: DECbit, Random Early Detection (RED), Source-Based Congestion Avoidance, Quality of Service: Application Requirements, Integrated Services (RSVP), Differentiated Services (EF, AF).	10

2	**Routing:**	IPv4 Routing Principles, Routing Information Protocol (RIP), IGRP and EIGRP, OSPF for IPv4 and IPv6, Border Gateway Protocol (BGP), EIGRP, High Availability Routing.	08
3	**IPv6**	IPv4 deficiencies, patching work done with IPv4, IPv6 addressing, multicast, Anycast, ICMPv6, Neighbour Discovery, Routing, Resource Reservation, IPv6 protocols.	06
4	**Network Design:**	Designing the network topology and solutions-Top down Approach: PPDIOO – Network Design Layers - Access Layer, Distribution Layer, Core/Backbone Layer, Access Layer Design, Backbone Network Design, Enterprise LAN Design: Ethernet Design Rules and Campus Design best practices, Virtualisation and Data Center Design, Wireless LAN Design, WAN Design: Traditional WAN Technologies, VPN Design.	14
5	**Ad Hoc Wireless Networks**	MAC Protocols for Ad Hoc Wireless Networks: MACA/W, MACA-BI, DPRMA, MACA/PR. Routing Protocols for Ad Hoc Wireless Networks: DSDV, DSR, AODV, ZRP. Transport Layer: ATCP.	06
6	**Software Defined Networking and OpenFlow**	Introduction to Software Defined Networking, Control and Data Planes, SDN Controllers, Introduction to Openflow Protocol, Network Function Virtualization-Concepts.	04

Text Books:

1. Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Elsevier, Fourth Edition.
2. Philip M. Miller, *TCP / IP: The Ultimate Protocol Guide Applications, Access and Data Security - Vol 2, Wiley*
3. Pete Loshin, IPv6: Theory, Protocols and Practice, Morgan Kaufmann, 2nd Edition, 2004
4. Anthony Bruno, Steve Jordan, Official Cert Guide: CCDA, Cisco Press,
5. C. Siva Ram Murthy, B.S. Manoj, Ad Hoc Wireless Networks: Architectures and, Prentice Hall, 2004.
6. Thomas D NAdeau and Ken Grey, Software Defined Networking, O'Reilly, 2013

Reference Books:

1. William Stallings, High-Speed Networks and Internets, Pearson Education, 2nd Edition, 2002.
2. James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Third Edition, Addison Wesley, 2004.
3. Pujolle, Software Networks: Virtualisation, SDN, 5G, Security, Wiley,

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
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Item No. – 4.10

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<tr><td rowspan="6">CSC103</td><td rowspan="6">Advanced Operating System</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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</table>

Course Objectives:

1. To learn the architectural differences and issues related to Advanced Operating System.
2. To get a comprehensive knowledge of the distributed systems and Real time operating system.
3. To get a thorough knowledge of database operating systems and cloud operating System.

Course Outcomes: Learner will able to

- Apply the principles and concepts in analyzing and designing Advance Operating System.
- Demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system
- Analyze the performance and reliability of different Advanced Operating Systems.

Sr. No.	Module	Detailed content	Hours
1	Introduction	• Types of Advanced Operating Systems. • Architectures and design issues of Network operating system, DOS, Middleware, RTS, DBOS. • Introduction to process, Concurrent processes, Critical Section problems, other synchronization problems.	04
2	Distributed operating Systems, Scheduling and synchronization	• Scheduling: Issues in load distributing, Components of load distributing algorithms, Stability, Load distributing algorithms, Performance Comparison, Selecting a suitable load sharing Algorithm. • Synchronization: Physical and logical clocks. • Distributed Mutual Exclusion: Introduction, Classification of Mutual Exclusion algorithms, Mutual Exclusion Algorithms.	12

		• Distributed Deadlock: Introduction, deadlock handling strategies, Deadlock detection: Issues and resolution, Control Organizations, Centralized algorithms, Distributed algorithms, Hierarchical algorithms.	
3	Distributed Fault Handling	• Agreement Protocol: System Model, Classification, Solution to Byzantine Agreement Problem. • Fault Recovery: Concepts, Classification of failures, Backward error recovery, Recovery in concurrent Systems, Consistent Check Points, Synchronous and Asynchronous check pointing and recovery. • Fault tolerance: Issues, Atomic actions and committing, Commit Protocols, Non-blocking Commit protocols, Voting protocols and Dynamic Voting Protocols.	10
4	Real Time Operating Systems	• Types of Real time tasks, Timing Constraints, Modeling Timing Constraints. • Task Scheduling: Types of tasks and their characteristics, Task Scheduling, Clock driven Scheduling , Hybrid Schedulers, Event driven Scheduling, EDF Scheduling, Rate Monotonic Algorithm • Resource Handling: Resource Sharing, Priority Inversion, PIP,PCP,HLP. • Scheduling real time tasks in distributed systems	12
5	Database Operating systems	• Concurrency control : Database systems, Concurrency control model of database systems, Problem of Concurrency Control, serializability theory, Distributed Database Systems • Concurrency Control Algorithms : Basic synchronization Algorithms, Lock based, Timestamp based and Optimistic Algorithms, Concurrency Control Algorithms : Data Replication	06
6	Case Study	• DOS: Mach, Amoeba • .RTOS : UNIX as RTOS , Windows as RTOS. • Mobile OS. • Cloud OS	04

Text books:

1. Mukesh Singhal, Niranjan G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems" .MC Graw Hill education.

2. Rajib Mall, “Real-Time Systems: Theory and Practice”, Pearson education.

Reference Books:

1. Andrew S.Tanenbaum, "Modern Systems Principles and Paradigms". PHI.
2. Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.
3. Andrew S.Tanenbaum, "Distributed Operating System", Pearson Education.
4. Jane W. S. Liu, “Real Time Systems”, Pearson education.

The suggested lists of experiment/case study of Advanced Operating System are as follows:

I. Flexibility/Load Distribution

1) Implement and study the incremental/decremented growth of response and service times for different number of client and servers for servicing continuous stream(s) of constant sized messages.
2) Implement a name server for registration and identification of services running on another server. The client contacts the name server for a particular service and the service request is forwarded to the specific server registered on the name server. Study the load distribution for different number of service servers, clients and service requests.

II. Fault Tolerance/Reliability

1) Implement a fault tolerant client and server application using the concept of name server. The client incorporates fault tolerant by sending a service request to another server using name server, if the current server fails to respond within 10 seconds.
2) Implement a stateful server for a transaction consisting of mainly four operations viz. open a file, close opened file, read from opened file and write to opened file. The state of file operation is maintained at stateful server.

III. Performance

1) Implement a client-server application for a computing problem (of exponential complexity). Compare the performance for a local and remote machine of different speeds.
2) Implement parallel Fast-Fourier-Transform (parallel FFT). Show that the overall communication time complexity is O ((n/p) log p), and the computational complexity of

the parallel algorithm is O (n log n/p) where n is number of elements, and p is number of processes.

IV. Transparency

1) Implement a client-server application to show transparent service access so that the client does not know the location of service is being executed.

V. Mobile Application

1) Implement a client-server application to allow transfer of any data (e.g. images, documents, videos etc.) on android mobile operating system. Each mobile device runs a program which acts as a server when it receives data from another device or a client when it sends data to another mobile device.
2) Implement a distributed share list among a group of mobile device users which is similar to Google document.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

AC- 30/07/2017

Item No. – 4.10

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSE1011	Logic & Automated Reasoning	04	--	--	04	--	--	04
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. Represent mathematical and other knowledge using logical formalism.
2. Understand theoretical concepts and results that form the basis of current automated reasoning systems.
3. Understand advanced techniques of resolution theorem proving and be able to use them.

Outcomes: Learner will be able to ...

- Comprehend syntax and semantics of Propositional logic, first-order logic, inference system, proof, soundness and completeness.
- Apply various deductive algorithms and models for reasoning
- Emphasize various techniques for automated reasoning, theorem proving

Sr. No.	Module	Detailed Contents	Hours
1	Introduction to Logic	• Mathematical Logic, Propositional Logic, First-Order Logic, Modal Logic, Temporal Logic, • Program Verification	04
2	Propositional Logic	• Formulas, Models, Tableaux: Propositional Formulas, Interpretations ,Logical Equivalence, Sets of Boolean Operators, Satisfiability, Validity and Consequence, Semantic Tableaux, Soundness and Completeness • Resolutions: Conjunctive Normal Form, Clausal Form, Resolution Rule, Soundness and Completeness of Resolution • Binary Decision Diagrams: Motivation Through Truth Tables, Definition of Binary Decision Diagrams, Reduced Binary Decision Diagrams	12
3	First-Order	• Formulas, Models, Tableaux: Relations and Predicates,	12

	Logic	Formulas in First-Order Logic, Interpretations, Logical Equivalence, Semantic Tableaux, Soundness and Completion of Semantic Tableaux • Resolution: Ground Resolution, Substitution, Unification, General Resolution, Soundness and Completeness of General Resolution • Introduction to Logic Programming: Prolog	
4	Reasoning Methods	• SAT Solvers: Properties of Clausal Form, • Davis-Putnam Algorithm, DPLL Algorithm • Deductive Systems: Gentzen System, Hilbert System • Terms and Normal Forms : First-Order Logic with Functions, PCNF and Clausal Form, Herbrand Models	08
5	Automated Reasoning	• Automated Reasoning for Web system, • Semantic Web applications, • REWERSE-automated reasoning method and tools,	06
6	Theorem Proving	• Some exposure to theorem proving systems such as Prolog, PVS, SPIN	06

Text Books

1. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer
2 Arindama Singh, Logics for Computer Science, Prentice Hall of India.

Reference Books

1. Handbook of Practical Logic and Automated Reasoning, John Harrison, Cambridge University Press
2. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
Note: One Case Study to be given for Module 5 and 6 based on the above concepts.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
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<tr><td rowspan="6">CSE1012</td><td rowspan="6">Image Analysis and Interpretation</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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Objective:

1. To explore the various Image Analysis and Interpretation techniques
2. To become accustomed with different methods of Feature generation, Representation Description and Interpretation.
3. To Analyze & Interpret Images and use for various applications

Outcome: Learner will able to

- Understand the importance of Image Analysis and Interpretation.
- Analyze various methods of Image Analysis
- Use the methods of image analysis and interpretation for various Image Processing applications.

Prerequisite: Image Processing, Mathematics**.**

Sr. No.	Module	Detailed content	Hours
1	Introduction to Image Processing System	• Introduction, • Sources of Images • Classification of Images • Elements of Image Processing System • Image Modelling – Sampling, Quantization and Representing Digital Images. • Image Preprocessing –	08

		○ Enhancement : Power Law Transformation, Contrast Stretching and Histogram Equalization ○ Spatial domain Filters: Smoothing, Sharpening	
2	Feature Generation	• Introduction • Basis Vectors and Images • K-L transformation • Singular Value Decomposition • Independent Component Analysis • Non–Negative Matrix Factorization • Non- linear Dimension Reduction • Haar Transform • Multi resolution Interpretation	12
3	Image Analysis	• Data Structure for Image Analysis ○ Levels of image data representation ○ Traditional image data structures ○ Hierarchical data structures • Image Segmentation ○ Thresholding ○ Edge based and Region Based Segmentation ○ Boundary Extraction • Feature Extraction ○ Spatial Feature Extraction ○ Transform Feature Extraction	10
4	Image Representation and Description	• Boundary Representation • Region Representation • Moments Representation • Structure Representation • Shape Representation • Texture Representation	06 .
5	Statistical decision making and Vector Quantization	• Statistical decision making: Bayesian theorem Multiple features Conditionally independent features Decision boundaries Unequal cost of error Estimation of error rates	08

		• Vector Quantization	
6	Applications	Case Study on • Remote Sensing Images • Medical Images • Image Forensics: Finger print classification • Digital Watermarking for Images	04

Text Books:

1. Fundamentals of Digital Image Processing Anil K. Jain, PHI
2. Pattern Recognition, Theodoridis & Koutroumbas, 4th Edition, Academic Press
3. Digital Image Processing ,Second Edition, Rafael C. Gonzalez and Richard E.Woods, Pearson Prentice Hall,
4. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar,Tata McGraw-Hill Education Private Limited, 2011.
5. Digital Image Processing, S. Sridhar, Oxford University Press.
6. Image Processing, Analysis, and Machine Vision, Milan Sonka Vaclav Hlavac Roger Boyle.
7. Pattern recognition and Image analysis by Earl Gose, Richard Johnsonbaugh, Steve Jost, PHI publication

Reference Books:

1. Digital Image Processing An Algorithm Approach, Madhuri A. Joshi, PHI
2. Principles of Soft Computing , S N Shivanandan, S N Deepa, Wiley

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Theory Examination:

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<tr><td rowspan="6">CSE1013</td><td rowspan="6">Natural Language Processing</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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Course Objectives:

1. To formulate the problems and solutions of NLP and establish their relation to linguistics and statistics.
2. To implement various language Models.
3. To design systems that uses NLP techniques
4. To train and evaluate empirical NLP systems.

Course Outcomes: At the end of the course student should be able to

- Model linguistic phenomena with formal grammars.
- Design, implement, and analyze NLP algorithms
- Apply NLP techniques to design real world NLP applications, such as machine translation, text categorization, text summarization, information extraction...etc.
- Implement proper experimental methodology for training and evaluating empirical NLP systems.

Prerequisite: Data structure & Algorithms, Theory of computer science, Probability Theory

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours

1	**Introduction**	History of NLP, Generic NLP system, levels of NLP , Knowledge in language processing , Ambiguity in Natural language , stages in NLP, challenges of NLP ,Applications of NLP- Machine translation, question answering system, Information retrieval, Text categorization , text summarization & Sentiment Analysis	3
2	**Word Level Analysis**	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology; Regular expression, finite automata, finite state transducers (FST) ,Morphological parsing with FST , Lexicon free FST - Porter stemmer. N –Grams- N-gram language model , N-gram for spelling correction .	9
3	**Syntax analysis**	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words, class based n –grams .Context Free Grammar – Constituency , Context free rules & trees, Sentence level construction , Noun Phrase, coordination, agreement, the verb phrase & sub categorization	10
4	**Semantic Analysis**	Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, Wordnet, Selectional restriction based disambiguation & limitations , Robust WSD – machine learning approach and dictionary based approach	10
5	**Pragmatics**	Discourse –reference resolution, reference phenomenon , syntactic & semantic constraints on co reference, preferences in pronoun interpretation , algorithm for pronoun resolution .Text coherence, discourse structure	8
6	**Applications (preferably for Indian regional languages)**	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis.	8

Text Books:

1. Daniel Jurafsky, James H. Martin “Speech and Language Processing” Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze, “ Foundations of Statistical Natural Language Processing “, MIT Press, 1999.

Reference Books :

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni " Multilingual natural language processing applications" Pearson, 2013
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) " The Handbook of Computational Linguistics and Natural Language Processing " ISBN: 978-1-118-

Case study/Experiments:

The objective of Natural Language Processing lab is to introduce the students with the basics of NLP which will empower them for developing advanced NLP tools and solving practical problems in this field.

Reference for Experiments: **http://cse24-iiith.virtual-labs.ac.in/#**

Sample Case study/Experiments:

Note: Although it is not mandatory, the experiments can be conducted with reference to any Indian regional language.

1. Word Analysis
2. Word generation
3. Stop word removal
4. Stemming
5. Morphology
6. POS Tagging
7. Chunking
8. N-gram language model

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

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<tr><td rowspan="6">CSE1014</td><td rowspan="6">Computational Intelligence</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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Course Objectives:

1. To explore the various computational Intelligence techniques
2. To become familiarized with Neural Network, Fuzzy logic & evolutionary techniques
3. To learn to apply computational Intelligence to different applications

Course Outcomes: Learner will able to

- Understand the importance of computational Intelligence.
- Analyze various computational Intelligence technology
- Design and implement various intelligent system.

Prerequisite: Soft Computing, Mathematics

Sr. No.	Module	Detailed content	Hours
1	Introduction to Computational Intelligence	Artificial Neural Networks, Fuzzy Systems, Genetic Algorithms, Swarm Intelligence, Artificial Immune System, Applications	6

	paradigms		
2	Artificial Neural Networks & SVM	Basic models of ANN: NN Architecture, MP Neuron, Linear separability, activation functions, types of learning Learning Rules: Hebbian, Perceptron, Delta, Winner-take all Supervised NN: Perceptron Network: SDPTA, SCPTA, MCPTA, Adaline networks Support Vector Machine: Binary SVM	14
3	Fuzzy Systems	Fuzzy Sets: Definition, operations, properties, relations, characteristics, membership functions, defuzzification.	8
4	Optimization	GA: Selection, Encoding, Crossover, Mutation, Examples. Swarm Intelligence: Single Solution Particle Swarm Optimization: Guaranteed Convergence PSO, Social-Based Particle Swarm Optimization, Hybrid Algorithms, Sub-Swarm Based PSO, Multi-Start PSO Algorithms, Repelling Methods, Binary PSO, Ant Algorithm: Simple Ant Colony Optimization	10
5	Artificial Immune System	Natural Immune System: Classical view, Antibodies and antigens, Artificial Immune Models: Artificial Immune system algorithm, classical view models, CLONALG	4
6	Applications	Character Recognition, Genetics Algorithm in game playing, Color Recipe prediction- Single MLP approach ANT algorithm/Swarm Intelligence – TSP, Best path finding	6

Text Books:

1. Computational Intelligence An Introduction, Andries P. Engelbrecht, Wiley, 2nd Edition
2. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Wiley, 2nd edition
3. Introduction to Artificial Neural Systems, Jacek M. Zurada, West Publication
4. Pattern Recognition, Theodoridis and Koutroumbas , 4th Edition, Academic Press

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<tr><td rowspan="5">CSE1021</td><td rowspan="5">User Experience Design</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
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</table>

Course Objectives:

1. To study and understand importance of user experience design principles
2. To understand elements of user experience design
3. To encourage students to participate in designing futuristic applications

Course Outcomes: Learner will be able to:

- To Apply principles of user experience
- To apply emerging and established technologies to enhance User Experience design
- To create interface for international standards with ethics
- To evaluate user experience.

Pre-requisites: Web Technologies; Software Engineering; Experience in designing interfaces for applications and web sites. Basic knowledge of designing tools and languages like HTML, Java, etc. User experience design is concerned with all the elements that together make up user interface, including layout, visual design, text, brand, sound, and interaction. User Experience Design works to coordinate these elements to allow for the best possible interaction by users.

Sr. No.	Module	Detailed Contents	Hours
1	Introduction	Introduction to interface design, Understanding and conceptualizing Interface, Understandinguser's conceptual cognition.	04
2	Elements of UX Design	Core Elements of User Experience, Working of UX elements	04
3	The UX Design Process – Understanding Users	Defining the UX, Design Process and Methodology, Understanding user requirements and goals, Understanding the Business Requirements/Goals, User research, mental models, wireframes, prototyping, usability testing.	08
4	The UX Design Process- The Structure: Information Architecture and Interaction Design	Visual Design Principles ,Information Design and Data Visualization Interaction Design ,Information Architecture , Wire framing & Storyboarding,UI Elements and Widgets, Screen Design and Layouts	08
5	UX Design Process: Prototype and Test	Testing your Design, Usability Testing,Types of Usability Testing ,Usability Testing Process, Preparing and planning for the Usability Tests, Prototype your Design to Test, Introduction of prototyping tools,conducting Usability Test, communicating Usability Test Results	08
6	UX Design Process: Iterate/ Improve and Deliver	Understanding the Usability Test,findings, Applying the Usability Test, feedback in improving the design. Communication with implementation team. UX Deliverables to be given to implementation team	04

Text Books

1. Interaction Design, Beyond Human Computer Interaction, Rogers, Sharp, Preece Wiley India Pvt Ltd.
2. The essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin
3. Designing The user Interface by Shneiderman, Plaisant,Cohen,Jacobs Pearson

Reference Books:

1. The Elements of User Experience by Jesse James Garrett
2. Don't make me think, by Steve Krug
3. Observing the User Experience: A Practitioner's Guide to User Research by Mike Kuniavsky

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
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<tr><td rowspan="6">CSE1022</td><td rowspan="6">Mobile and Adaptive System</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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</table>

Course Objectives:

1. Understand various Mobile and wireless systems
2. Study Architecture and various processes of GSM
3. Provide the knowledge of concept of Mobile IP and related issues
4. Detailed study of security issues in Ad-hoc networks

Course Outcomes: Learner will able to -

- Gain knowledge about Voice and Data communication wireless systems
- Able to develop and design mechanisms for Mobile and wireless communication.
- Demonstrate the technical competence necessary for solving problems in Mobile and wireless systems.

Sr. No.	Module	Detailed Content	Hours
1	Introduction and overview	General issues that will be addressed on this module. Properties of wireless PANs, LANs, WANs, Basic structure and operation, Ad-hoc and Infrastructure networks. Physical constraints and limitations (transmission & reception).	8
2	Network structures and architectures	Hand-off and mobility support at the physical/link level. Technologies at physical link layer. PANs Bluetooth, LANs IEEE802.11, Hiper LAN.	8
3	Global system for mobile communication (GSM)	Mobile Services, System Architecture, Protocols, Localization & Calling, Handover, Security. GPRS: GPRS System Architecture. UMTS: UMTS System Architecture.LTE: Long Term Evolution.	10
4	Mobile IP	Mobile IPv4 and Mobile IPv6. Problems with routing, QoS and security. Overview of use of intelligence in mobile systems, Power management, replication, adaptation. Power management issues. From the lowest (physical device) levels, through communication protocols, broadcast methodologies, trans coding, etc.	8
5	File Systems	CODA, Mobile Infrastructure support, Mobile middleware, Adaptive and reconfigurable Systems, Next generation wireless overview (4G/5G): UMTS, IMT 2000 and W-CDMA.	8
6	Mobile multimedia and their relationship to proxying	Programmable networking and Applications for mobile systems. Code mobility and control/signaling.	6

Text Books:

1. Jochen Schiller, “Mobile Communications”, Pearson Education, Second Edition, 2008.
2. Dr. Sunilkumar, “Wireless and Mobile Networks: Concepts and Protocols”, Wiley Publication.

Reference Books:

1. Raj Kamal, “Mobile Computing”, OXFORD UNIVERSITY PRESS.
2. Ed. Dejan Milojicic, Frederick Douglis and Richard Wheeler, “Mobility: Processes, computers and agents." ACM Press.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
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<tr><td rowspan="6">CSE1023</td><td rowspan="6">Advanced Network Programming</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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Course Objectives:

1. Provide students with a thorough introduction to a variety of important principles in networking, with a strong focus on the Internet.
2. Learn to write programs using the socket interface.
3. Give an introduction to the TCP/IP client-server model of interaction, and to writing networking applications using the client/server technology.
4. Discussion on writing of secure software.

Course Outcomes: Learner will able to -

- Write socket API based programs

- Design and implement client-server applications using TCP and UDP sockets
- Understand with several common programming interfaces for network communication
- Formulate the basic concept of socket programming and client server model

Sr. No.	Module	Detailed Content	Hours
1	Transport Layer	TCP and UDP with policy control, TCP Connection Establishment and Termination, TIME_WAIT State, Port Numbers and Concurrent Servers, Buffer Sizes and Limitations.	6
2	Sockets and Socket Programming	Introduction, Socket Address Structures, Value-Result Arguments, Byte Ordering Functions, Byte Manipulation Functions, socket Function.	8
3	Application Development	TCP Echo Server: main and str_echo Function, TCP Echo Client: main and str_cli Function, Normal Startup, Normal Termination, POSIX Signal Handling, SIGPIPE Signal, wait and waitpid function Connection abort before accept return, Termination of server process, Crashing of Server Host, Crashing and Rebooting of Server Host and Shutdown of Server Host.	10
4	Socket Option and Elementary UDP Socket	Getsocket and setsocket functions – generic socket options, IP socket options, ICMP socket options, Elementary UDP sockets: UDP echo Server, UDP echo Client, Multiplexing TCP and UDP sockets.	8
5	Advanced Sockets	IPv4 and IPv6 Interoperability: IPv4 Client, IPv6 Server, IPv6 Client, IPv4 Server, IPv6 Address Testing Macros, IPV6_ADDRFORM Socket Option ICMPv4 and ICMPv6. Name and Address Conversions: Domain Name System, Functions. Advanced Name and Address Conversions: Functions and Implementation Threads: Thread Functions: Creation and Termination, Thread-Specific Data, Web Client and Simultaneous Connections	8
6	Routing Sockets	Data link Socket, Address Structure, Reading and Writing, Interface Name and Index Functions, data link access, raw socket (creation input, output) Client-Server Design Alternatives: TCP Client Alternatives, TCP Test Client, Iterative Server, Concurrent Server, Thread Locking around accept, Descriptor Passing, TCP Concurrent Server, One Thread	8

		per Client, TCP Pre-threaded Server.	

Text Books:

1. Richard Stevens, Bill Fenner, "UNIX network programming Volume-1 - The Sockets Networking API", 3rd edition.
2. W. Richard Stevens, "Advanced Programming in the Unix Environment", Addison Wesley.

Reference Books:

1. UNIX Internals – "A new Frontier", PHI

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 2 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

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<tr><td rowspan="6">CSE1024</td><td rowspan="6">Operations Research</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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</table>

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures.

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer	14

	Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

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<tr><td rowspan="6">CSL101</td><td rowspan="6">Lab-I: Computational Laboratory on Core Courses</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
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</table>

Module	Detailed Content	Lab Session
Algorithm and Complexity	• Implementation of algorithms which demonstrate greedy strategy, dynamic programming, Flow network, parallel algorithm and string matching (any two).	02

Networking Design	• Install tool CISCO Packet Tracer Student Edition (open-source). Explore this tool and use it to design an Internetwork using switches, routers and the concept of VLAN. Configure different routing protocols like RIP, OSPF, EIGRP etc. on the network you have designed and observe the performance. Test your network using "ping" and "show ip route". • Install mininet (open-source). Create virtual architecture for SDN openvswitch(s), host(s), controllers(s) and test various topologies using basic commands like ping. Optionally connect mininet openvswitch with external controllers like open day light (open-source).	05
Advanced Operating System	• The Advanced Operating System laboratory work should clarify the basic concepts of **Flexibility / Load Distribution** (system scales easily to accommodate increase in number of machines with corresponding increase in performance), **performance** (running an application should not be appreciably worse than running it on a single CPU system), **reliability** (system should be available and functional in presence of failures) and **transparency** (system should provide a single system image). • Every student should perform at least two experiments from above categories (i.e. Flexibility/Load Distribution, Fault Tolerance/Reliability, Performance, Transparency and Mobile Application) using C / C++ programming language.	05

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

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<tr><td rowspan="6">CSL102</td><td rowspan="6">Lab-II :Laboratory on Elective Courses</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
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</table>

Design and implementation of any case study/ applications based on Elective-I and Elective-II using modern tools.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

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<tr><td rowspan="6">CSC201</td><td rowspan="6">High Performance Computing</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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Course Objectives:

1. To learn concepts of parallel processing as it pertains to high-performance computing.
2. To design, develop and analyze parallel programs on high performance computing resources using parallel programming paradigms

Course Outcomes: Learner will be able to:

- Understand different parallel processing approaches and platforms involved in achieving High Performance Computing.
- Understand design Issues and limitations in Parallel Computing.
- Learn to programming using message passing paradigm using open source APIs, design algorithms suited for Multicore processor and GPU systems using OpenCL, OpenMP.
- Analyze and optimize performance parameters.
- Understand HPC enabled Advanced Technologies.

Sr.No	Module	Detailed Content	Hours
1	Parallel Processing approaches	**Introduction to Parallel Processing:** Levels of Parallelism (instruction, transaction, task, thread, memory, and function), Models (SIMD, MIMD, SIMT, SPMD, Data Flow Models, Demand-driven Computation etc.). Loosely coupled and Tightly coupled **HPC Platforms:** Message-passing interface (MPI), Shared-memory thread-based OpenMP programs, hybrid (MPI/OpenMP) programs, Grid Computing, Cloud Computing , Multi-Core Processors, accelerators, GPGPUs	06
2	Design Issues and limitations in Parallel Computing	Parallel Architecture, (Interconnection network, processor Array, Multiprocessor) Designing Parallel algorithms (Partitioning, Communication, Mapping, Matrix input/output) **Issues:** Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures **Limitations:** Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations	10
3	Programming using message passing paradigm	Principles, building blocks, MPI, Overlapping communication and computation, collective communication operations, Composite synchronization constructs, OpenMP Threading Building blocks; An Overview of Memory Allocators, Parallel programming model, combining MPI and OpenMP, Shared memory programing	10

4	Parallel Programming using GPGPU	An Overview of GPGPUs, An Overview of GPGPU Programming, An Overview of GPGPU Memory Hierarchy Features, Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL	12
5	Performance Measures	Performance measures: Speedup, efficiency and scalability. Abstract performance metrics (work, critical paths), Amdahl`s Law, Gustavson's law, weak vs. strong scaling, performance bottlenecks, data races and determinism, data race avoidance (immutability, futures, accumulators, dataflow), deadlock avoidance, abstract vs. real performance (granularity, scalability)	06
6	HPC enabled Advanced Technologies	Nanotechnology and its impact on high performance computing, Power aware processing techniques in high performance computing. Case studies on high performance computing	04

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. Kai Hwang,Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill,Second Edition, 2010.
3. Edward Kandrot and Jason Sanders, "CUDA by Example – An Introduction to General Purpose GPU Programming",Addison-Wesley Professional ©, 2010.
4. Benedict R Gaster, Lee Howes, David R KaeliPerhaad Mistry Dana Schaa, "Heterogeneous Computing with OpenCL", Elsevier, Second Edition, 2013.

Reference Books:

1. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.
2. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill International Editions, Computer Science Series, 2008.
3. Kai Hwang, Zhiwei Xu,"Scalable Parallel Computing: Technology, Architecture, Programming", McGraw Hill, 1998.

4. Laurence T. Yang, MinyiGuo, "High- Performance Computing: Paradigm and Infrastructure" Wiley, 2006.

List of Experiments to be included in Computational Lab II

Solve given problems using OpenMP/MPI/OpenCL and compare their performance on CPU and GPGPU.

1. Matrix-Matrix multiplication – simple/Cannon's/ DNS algorithm
2. Sorting – Bitonic/Shell sort/Quicksort/Bucket/ Radix
3. All-pairs shortest paths – Dijkstra's algorithm/Floyd's algorithm

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
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<tr><td rowspan="6">CSC202</td><td rowspan="6">Data Science</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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</table>

Course Objectives:

1. To understand the foundations of the Data Science process, methods and techniques
2. To represent and organise knowledge about large heterogeneous data collections

3. To use mathematical models and tools for large-scale data analysis and reasoning
4. To work and evaluate Data at Scale – Working with Big Data

Course Outcome: Learner will able

- Learn the fundamentals of data science to enable, reproduce and scalable data from a variety of sources.
- Apply statistical methods, regression techniques, and machine learning algorithms to make sense out of data sets both large and small.
- Design, implement, and evaluate the core algorithms underlying an end-to-end data science workflow, analysis, and visualization of information derived from large datasets.
- Apply "best practices" in data science with modern tools

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Data Science	Data science process: Defining goal, retrieving data, preprocessing data, exploratory data analysis, model building and data visualization, Ethical issues in data science. Probability: review of probability theory, normal distribution, Gaussian discriminant analysis: Linear discriminant analysis (LDA), Logistic regression: Bayesian logistic regression,	08
2	Predictive and Descriptive Models	Descriptive Modeling: Principal components analysis (PCA), singular value decomposition (SVD), probabilistic PCA, applying PCA to new data, PCA for data interpretation., EM algorithm for PCA, Independent Component Analysis (ICA), Maximum likelihood estimation using EM. Predictive Modeling: Predictive modeling process, supervised and unsupervised learning, parametric and non-parametric models, business intelligence, challenges in using predictive analytics Introduction to time series analysis and time series mining, Introduction to spatio-temporal data, spatio-temporal model, fast dynamic time warping.	12
3	Evaluation and Methodology of Data Science	Experimental setups, training, tuning, test data, holdout method, cross-validation, bootstrap method Measuring performance of a model: Accuracy, ROC curves, precision-recall curves, loss functions for regression Interpretation of results: Confidence interval for accuracy,	03

		hypothesis tests for comparing models, algorithms.	
4	Text Analytics and Recommendation system (RS)	Introducing text mining, text mining techniques, Understanding Text Mining Process, Sentiment Analysis. Introduction to RS, content based RS, collaborative RS, hybrid RS. Issues and challenges RS, examples of real word RS, e.g., Amazon, mobile RS, etc.	08
5	Data Communication and Information Visualization	Data Communication: cost Function, how to Minimize cost function, coefficients of determination. Information visualization: effective information visualization, visual Encodings, perception of visual cues, data scales, visualizing time series data, data journalism, dashboards.	08
6	Scaling with Big Data	Introduction of big data, characteristics of big data, data in the warehouse and data in Hadoop, Importance of Big data, Big data Use cases: patterns for Big data deployment, MapReduce and Hadoop Ecosystem architecture, NoSQL,analyzing data with Pig and R.Sharding, indexing large-scale data, sampling, data leakage, data incest.	09

Reference Books:

1. Davy Cielen,Meysman,Mohamed Ali, “Introducing Data Science”, Dreamtech Press
2. Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
3. Paul C. Zikopoulos, Chris Eaton, Dirk deRoos, Thomas Deutsch and George Lapis, “Understanding Big Data: Analytics for Enterprise Class Hadoop and streaming Data”, The McGraw Hill Companies, 2012
4. Dean Abbott, “Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst”, Wiley, 2014
5. Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley
6. Seema Acharya and SubhashiniChellappan, “Big Data and Analytics”, Wiley
7. Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
8. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
9. EMC Education Services,”Data Science and Big Data Analytics”,Wiley
10. DT Editorial Services, “Big Data Black Book”, Dreamtech Press

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">CSC203</td><td rowspan="6">Ethical Hacking and Digital Forensics</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
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<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Course Objectives:

1. To understand underlying principles and many of the techniques associated with the digital forensic practices.
2. To explore practical knowledge about ethical hacking Methodology.
3. To develop an excellent understanding of current cyber security issues and ways that user, administrator and programmer errors can lead to exploitable in securities.

Course Outcomes: Learner will able to

- Understand the concept of ethical hacking and its associated applications in Information Communication Technology (ICT) world.
- Acquire knowledge of various digital forensic tools and ethical hacking.
- Interpret security issues in ICT world, and apply digital forensic tools for security and investigations.
- Achieve adequate perspectives of digital forensic investigation in various applications /devices like Windows/Unix system, mobile, email etc.
- Generate legal evidences and supporting investigation reports.

Sr. No.	Module	Detailed content	Hours
1	Ethical Hacking Methodology	Introduction, Steps of Ethical Hacking: Planning, Reconnaissance, Scanning, Exploitation, post exploitation and result reporting. Ethical Hacking Tool: Metasploit	6Hrs
2	Introduction to Digital Forensics	The Need for Digital Forensics, Types of Digital Forensics, Introduction to Incident Response Methodology, Incident handling steps, Ethics in Digital Forensics.	6 Hrs
3	Data Collection	Live Data Collection from Windows and Unix Systems, Tools for Forensic Duplication, Collecting Network-based Evidence, Evidence Handling - Chain of Custody. Data Collection Forensic Tools : Forensics Toolkit/ WinHex	14 Hrs
4	Data Analysis	Data Analysis, Investigating Windows, Unix Systems, Analysing Network Traffic, Investigating Routers, Email forensics Data Analysis Tools : Nmap/Wireshark/Helix3pro	12 Hrs
5	Mobile Device Forensics	Crime and mobile phones, evidences, forensic procedures, files present in SIM cards, device data, external memory dump, and evidences in memory card, operator's networks.	6 Hrs
6	Forensic Investigation Reporting	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report	4 Hrs

Text Books:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGraw Hill, 2006.
2. Patrick Engebretson, “The Basics of Hacking and Penetration Testing, Second Edition: Ethical Hacking and Penetration Testing Made Easy“, 2nd Edition, Syngress.
3. Investigation Procedures and Response**,** EC-Council Press.

Reference Books:

1. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999.
2. Debra Littlejohn Shinder and Ed Tittel, “Scene of the Cybercrime: Computer Forensics Handbook”, Syngress Publishing, Inc.
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools andTechnology", Academic Press, 1st Edition, 2001
4. Nina Godbole, “Information Systems Security”, Wiley India, New Delhi
5. William Stallings, “Cryptography and Network Security”, Pearson Publication

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Theory Examination:

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<tr><td rowspan="6">CSE2031</td><td rowspan="6">Data Storage and Retrieval</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
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</table>

Course Objectives:

1. Understand need of storage network with its architecture, features, components, topology, benefits and limitations.
2. Study the impact of downtime in terms of losses and business continuity.
3. Understand the basic terminologies and components in information retrieval systems.
4. Compare and contrast Information Retrieval models.

Course Outcomes: Learner will able to…

- Evaluate storage architecture, ISS, SAN, NAS and IP SAN.
- Design the storage infrastructure for business continuity.
- Implement and evaluate various Information Retrieval Models.

Sr. No.	Modules	Detailed content	Hours
1	Introduction to Data Storage	Need for storage network, Evolution of storage technology and architecture, Key Challenges in managing information, Information lifecycle, Disk drive performance, Fundamental laws governing disk performance.	04
2	Storage System Environment	Basic Software for Storage Networking: Software for SANs, Shared access data managers, Volumes(RAID): Resilience, performance and flexibility, File systems and application performance. Intelligent Storage System:Storage Virtualization: Form of Virtualization, storage virtualization configurations and challenges, Types of storage virtualization. Content-Addressed Storage: Architecture, Object storage and Retrieval in CAS.	08
3	Storage Networking Technologies	Storage Area Networks: Fibre Channel, Components of SAN, FC Connectivity, Fibre Channel Ports, Fibre Channel Architecture, Zoning, Fibre Channel Login Types, FC Topologies. Network-Attached Storage: General-Purpose Servers vs. NAS Devices, Benefits of NAS, NAS File I/O, Components of NAS, NAS Implementations, NAS File-Sharing Protocols, NAS I/O Operations, Factors Affecting NAS Performance and Availability. IP SAN: iSCSI, FCIP.	12

4	Business Continuity and Enterprise backup	Introduction to Business Continuity: Information availability, BC planning lifecycle, Failure Analysis, Business impact analysis. Enterprise backup software for SAN: Backup management, Enterprise data protection, Backup architecture, Backup policies, Minimizing impact of backup, Lan-free and serverless backup.	06
5	Information Retrieval	Introduction to Information Retrieval(IR), Objectives and Components of IR system, Taxonomy of IR models, Information Retrieval process, Documents and Query forms	06
6	Retrieval Models	Query structure, The matching process, Text analysis	10

Text Books:

1. G. Somasundaram, Alok Shrivastava, "Information Storage and Management", EMC Education services", Wiley Publication, Edition 2009
2. Richard Barker, Paul Massiglia, "Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs", Wiley India
3. Robert R. Korfhage, "Information Storage and Retrieval", Wiley Publication

Reference Books:

1. Ulf Troppens,Wolfgang Muller-Friedt,Rainer Wolafka, "Storage Networks Explained" Wiley Publication
2. Spalding, Robert. Storage Networks: The Complete Reference. Tata McGraw-Hill Education, 2003
3. Manning, Christopher D., Prabhakar Raghavan, and Hinrich Schütze. Introduction to information retrieval. Vol. 1, no. 1. Cambridge: Cambridge university press, 2008.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

AC- 30/07/2017

Item No. – 4.10

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><td rowspan="6">CSE2032</td><td rowspan="6">Internet of Things</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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Course Objectives:

5. Provide an overview of concepts, main trends and challenges of Internet of Things.
6. Develop the ability to use Internet of Things related software and hardware technologies.
7. Provide the knowledge of data management business processes and analytics of IoT.
8. Develop skills to relate the IoT technologies for practical IoT applications such as smart objects.

Course Outcomes: Learner will able to -

- Explain and interpret the Internet of Things concepts and challenges.
- Experiment with the software and hardware IoT Technologies.
- Understand data management and business processes and analytics of IoT
- Design and develop small IoT applications to create smart objects

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Internet of Things	IoT Paradigm, IoT Architecture – State of the Art, IoT Protocols, IoT Communication Models, IoT in Global Context, Cloud Computing, Big Data Analytics, Concepts of Web of Things, Concept of Cloud of Things with emphasis on Mobile Cloud Computing, Smart Objects.	8
2	Open – Source Prototyping Platforms for IoT	Basic Arduino Programming Extended Arduino Libraries, Arduino – Based Internet Communication, Raspberry PI, Sensors and Interfacing.	8
3	IoT Technology	RFID + NFC, Wireless Networks + WSN, RTLS + GPS, Agents + Multi – Agent Systems, Composition Models for the Web of Things and resources on the Web, Discovery, Search, IoT Mashups and Others.	8
4	Wireless Sensor Networks	History and Context, The Node, Connecting Nodes, Networking Nodes, Secured Communication for IoT.	4
5	Data Management, Business Process and Analytics	Data Management, Business Process in IoT, IoT Analytics, Creative Thinking Techniques, Modification, Combination Scenarios, Decentralized and Interoperable Approaches, Object – Information Distribution Architecture, Object Naming Service (ONS), Service Oriented Architecture, Network of Information, Etc.	12
6	Application and	Concrete Applications and Use – Cases of Web Enabled	8

	Use Cases	Things: Energy Management and Smart Homes, Ambient Assisted Living, Intelligent Transport, Etc. M2M, Industrial IoT Applications.	

Text Books:

3. The Internet of Things (MIT Press) by Samuel Greengard.
4. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi ,Wiley .
5. Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madisetti.

Reference Books:

3. The Internet of Things Key applications and Protocols, 2nd Edition, (Wiley Publication) by Olivier Hersent, David Boswarthick and Omar Elloumi.
4. IoT –From Research and Innovation to Market development, River Publication by Ovidiu Vermesan and Peter Friess.
5. Building Internet of Things with Arduino by Charalampos Doukas.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

5. Question paper will comprise of total six question
6. All question carry equal marks
7. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
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In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><td rowspan="5">CSE2033</td><td rowspan="5">Advanced Soft Computing</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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Course Objectives:

1. To familiarize various soft computing techniques.
2. To relate various soft computing techniques in practical scenario.
3. To understand hybrid approach for application development.

Course Outcomes: At the end of the course, the learner will be able to-

- To demonstrate various soft computing techniques.
- To apply and analyze different soft computing techniques for solving practical applications.
- To design an intelligent system for social and technical problems.

Pre-requisite: Basic mathematics, soft computing, Computational intelligence

Sr. No.	Module	Detailed content	Hours
1	Introduction	Differentiate Hard and Soft Computing, Soft Computing Constituents, Neuro Fuzzy and Soft Computing Characteristics	2
2	Fuzzy Logic & Rough Set Theory	Fuzzy Relations and Fuzzy Rules, Generalized Modens Ponens, Defuzzification and its Types Fuzzy Inference Systems, Design of Fuzzy Controller, Introduction to Rough Sets	12
3	Supervised Network	Error Back Propagation Training Algorithm, Radial Basis Function	10
4	Unsupervised Network	Kohenon Self Organizing Maps, Basic Learning Vector Quantization, Basic Adaptive Resonance Theory	12
5	Hybrid Systems and Introduction to Deep Learning	Fuzzy-Neural Systems, Neuro-Genetic Systems Fuzzy-Genetic Systems, Deep Learning : Definition & background, historical context of deep learning, Three classes of deep learning network.	8
6	Applications and Case Study	Automobile Fuel Efficiency using ANFIS Color Receipe prediction using CANFIS	4

Text Books

1. J.S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
2. S. Rajasekaran and G.A. Vijaylakshmi Pai.. Neural Networks Fuzzy Logic, and Genetic Algorithms, Prentice Hall of India.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
4. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
5. Samir Roy, Udit Chakraborty "Introduction to Soft Computing" Pearson Education India.
6. Jacek.M.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.
7. Timothy J.Ross "Fuzzy Logic With Engineering Applications" Wiley.

Reference Books:

1. Fakhreddine O. Karry, Clarence De Silva," Soft Computing and Intelligent systems Design Theory, Tools and Applications" Pearson 2009.
2. Li Deng and Dong Yu , 'Deep Learning Methods and Applications'.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

9. Question paper will comprise of total six question
10. All question carry equal marks
11. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
12. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><td rowspan="6">CSE2034</td><td rowspan="6">Semantic Web & Social Network Analysis</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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Semantic Web provide a graph model (RDF), a query language (SPARQL) and schema definition frameworks(RDFS and OWL) to represent and exchange knowledge online. These technologies provide a whole new way of capturing social networks in much richer structures. Social network Analysis(SNA) tries to understand and exploit the key features of social networks in order to manage their life cycle and predict their evolution. Objective of the course is to understand how to facilitate and enhance the analysis of online social networks, exploiting the power of semantic web technologies.

Course Objectives (CEO):

1. To understand the basics of Semantic Web Technologies
2. To Learn knowledge representation for Semantic Web
3. To understand the importance of Social Network Analysis
4. To understand and use semantic web technologies for social network analysis

Course Outcomes: At the end of the course, the students will be able to :

- Understand the Semantic Web and Social Networks
- Understand Electronic sources for network analysis and different ontology languages.
- Model and aggregate social network data.
- Design and Analyze social network using semantic web technologies.

Pre-requisites: Web Technologies; Data Structures, Databases, Logic-First order logic, knowledge representation, Data Mining ,Distributed Systems.

Sr. No.	Module	Detailed Contents	Hours
1	Introduction Semantic Web and Social Networks: .	The Semantic Web- Limitations of the current Web, The semantic Web Technologies ,A Layered Approach, The emergence of the social web. Social Network Analysis- What is network analysis, Development of Social Network Analysis, Key concepts and measures in network analysis	**04**
2	Semantics and Knowledge Representation on the Semantic Web	Electronic sources for network analysis- Electronic discussion networks, Blogs and online communities Structured Web Documents-XML, Describing web Resources-RDF, RDFSchema, Querying Knowledge Representation on the Semantic Web-SPARQL	**10**
3	Modeling and aggregating social network data:	Ontologies and their role in the Semantic Web, Ontology languages for the Semantic Web-RDFS, OWL. State-of-the-art in network data representation, Ontology Engineering, Semantic Web Knowledge Management Architecture ,Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data.	**10**
4	Developing social-semantic applications:	Building Semantic Web applications with social network features, Flink: the social networks of the Semantic Web community, open academia: distributed, semantic-based publication management	**08**

5	Extracting and Mining Communities in social network and social network analysis-	Extracting evolution of Web Community from series of web archive – Detecting communities in social networks- Definition of community – Evaluating communities – methods for community detection and mining – Semantic based social network analysis.	**08**
6	Applications of community mining algorithms , Visualization-	Applications of community mining algorithms-Influence and Homophily, Recommendation, Behavior Analytics, Visualization- Graph theory – Centrality – Clustering- Node Edge Diagrams –Matrix Representation –,Benefits of semantic social networks for communities	**08**

Text Books:

1. Grigoris Antoniou and Frank van Harmelen "Semantic Web Primer"second edition
2. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
3. Reza Zafarani,Mohammad Ali Abbasi,Huan Liu "Social Media Mining: Introduction",Cambridge University press.

Reference Books:

1. Guandong Xu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking Techniques and applications", First Edition Springer, 2011.
2. Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.
3. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, "Collaborative and Social Retrieval and Access: Techniques for Improved user Modelling",IGI Global Snippet, 2009.
4. John G. Breslin, Alexander Passant and Stefan Decker, "The Social Semantic Web", Springer, 2009.
5. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2011.
6. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.
7. Toby Segaran,colin Evans and Jamie Taylor "Programming Semantic Web", O'Reilly.
8. Berners Lee, Godel and Turing "Thinking on the Web ",Wiley inter science, 2008.
9. Vladimir Geroimenko, Chaomei Chen "Visualizing the Semantic Web", Springer 2006.

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Theory Examination:

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<tr><td rowspan="6">CSE2041</td><td rowspan="6">Information and Communication Technologies (ICT) for Social Cause</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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</table>

AC- 30/07/2017

Item No. – 4.10

Course Objectives:

1. To understand use of ICT techniques in various applications.
2. To Recognize, Represent and Design the ICT systems for social cause.

Outcome: Learner will able

- To understand technologies used in ICT.
- To design and implement ICT application for societal benefits
- To demonstrate use of emerging technology for social applications.

Sr. No.	Module	Detailed content	Hours
1	Basics of ICT	▪ Introduction to ICT ▪ Challenges and opportunities in using technology for a social cause. ▪ Understanding the social and cultural influences that affect users. ▪ Creating an ICT – handling text, data and media	4
2	Communication Techniques in ICT	▪ Mobile Techniques – CDMA, Mobile wireless WiMAX, Advanced wireless technologies, Bluetooth ▪ Satellite Techniques – architecture AND working principles GPS/GPRS ▪ Cloud computing – Introduction, cloud services, Cloud service providers, ▪ GIS– Working principle and architecture for ICT	12
3	Data acquisition in ICT	• Recognition systems RFID,OMR • Data acquisition process for MEMS devices • Sensors – Programming, communication with cloud. • Formation of social groups and interaction analysis Facebook, Twitter, Blogs, Forums, mailing lists etc	8
4	Data Management in ICT	▪ Data management ▪ Data storage structures	8
5	knowledge management in ICT	▪ Knowledge elicitation ▪ Knowledge Engineering Methodology ▪ Knowledge representation and visualization techniquesAutomatic discovery programs ▪ Data visualization ▪ Auditing knowledge management ▪ Linking knowledge management to business performance	8

6	ICT applications and Social Audit	• Study of ICT applications in various domains such as Agriculture, Healthcare, Education, SCM, Finance, Law. • Social Audit: The Social Audit Tool (SAT), Social Auditing, Characteristics of the SAT, Uses of the SAT , Benefits of the SAT, The SAT Methodology , Purposes, Method, and Approach of the SAT, Implementing the SAT, The Social Auditor	10

References Books:

1. ICT Futures :Delivering Pervasive Realtime And Secure Services Edited By Paul Warren, Jhon Davies, David Brown , Wiley Publication
2. Jochen Schiller, "Mobile communications", Addison wisely, Pearson Education.
3. GIS Fundamentals, Applications and Implementation, Dr.K.Elangovan, New India Publications.
4. Cloud Computing : A practical Approach: By Anthony T. Velte : Tata McGraw-Hill
5. An Introduction to Microelectromechanical systems Engineering, NadimMaluf , Artech House.
6. Knowledge management business intelligence , and content management : The IT practitioner's Guide by Jessica Keyes
7. ICTs for transfer of technology tools and techniques , S.R. Verma , New India
8. USAID, Social Audit Tool Handbook, Using the Social Audit to Assess the Social Performance of Microfinance Institutions,2008.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks

3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">CSE2042</td><td rowspan="6">Internet Routing Design</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Examination</td><td rowspan="3">Term Work</td><td rowspan="3">Pract</td><td rowspan="3">Oral</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
</table>

		20	20	20	80	--	--	--

Course Objectives:

1. To understand in depth Routing protocols used on Internet
2. To know about routing related issues on Internet
3. To develop the thinking about how to analyze Network Algorithms
4. To become familiar with the concepts of Traffic Engineering

Course Outcomes: Learner will able to –

- gain knowledge about various Routing protocols used on Internet.
- design Routing protocol for Internet.
- demonstrate the technical competence necessary for solving problems in Routing on Internet.

Sr. No.	Module	Detailed content	Hours
1	Networking and Network Routing: An Introduction	Addressing and Internet Service: An Overview, Network Routing, IP Addressing, Service Architecture, Protocol Stack Architecture, Router Architecture, Network Topology, Architecture, Network Management Architecture, Public Switched Telephone.	8
2	Routing Algorithms	OSPF and Integrated IS-IS: OSPF: Protocol Features, OSPF Packet Format, Integrated IS-IS, Key Features, comparison BGP: Features, Operations, Configuration Initialization, phases, Message Format. IP Routing and Distance Vector Protocol Family: RIPv1 and RIPv2.	8
3	Routing Protocols :Framework and Principles	Routing Protocol, Routing Algorithm, and Routing Table, Routing Information Representation and Protocol Messages. Internet Routing and Router Architectures: Architectural View of the Internet, Allocation of IP Prefixes and AS Number, Policy-Based Routing, Point of Presence, Router Architectures: Functions, Types, Elements of a Router, Packet Flow, and Packet Processing: Fast Path versus Slow Path, Router Architectures.	8
4	Analysis of Network Algorithms	Network Bottleneck, Network Algorithmic, Thinking Algorithmically, Refining the Algorithm, Cleaning up, Characteristics of Network Algorithms. IP Address Lookup Algorithms : Impact, Address Aggregation, Longest Prefix Matching, Naïve Algorithms, Binary, Multi-bit and Compressing Multi-bit Tries, Search by Length Algorithms, Search by Value Approaches, Hardware Algorithms, Comparing Different Approaches. IP Packet Filtering and Classification: Classification, Classification Algorithms, Naïve Solutions, Two-Dimensional Solutions, Approaches for *d* Dimensions.	10

5	Quality of Service Routing	QoS Attributes, Adapting Routing: A Basic Framework. Update Frequency, Information Inaccuracy, and Impact on Routing, Dynamic Call Routing in the PSTN, Heterogeneous Service, Single-Link Case, A General Framework for Source-Based QoS Routing with Path Caching	8
6	Routing and Traffic Engineering	Traffic Engineering of IP/MPLS Networks, VPN Traffic Engineering, Problem Illustration: Layer 3 VPN, LSP Path Determination: Constrained Shortest Path Approach, LSP Path Determination: Network Flow Modeling Approach, Layer 2 VPN Traffic Engineering,	6

Text Books:

1. Network Routing: Algorithms, Protocols, and Architectures Deepankar Medhi and Karthikeyan Ramasamy (Morgan Kaufmann Series in Networking)
2. Network Algorithmics: An Interdisciplinary Approach to Designing Fast Networked Devices George Varghese (Morgan Kaufmann Series in Networking)

Reference Books:

1. Sam Halabi and Danny McPherson, Internet Routing Architecture, Second Edition, Cisco Press

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSE2043	Grid and Cloud	04	--	--	04	--	--	04
		Examination Scheme						

	Computing	Theory Examination				Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	100	--	--	100

Course Objectives:

1. Classify and describe the architecture and taxonomy of parallel and distributed computing,
2. Get familiarized with the role of Cloud computing.
3. Make the students understand basic knowledge of grid computing
4. Familiarized with virtualization concepts and Service Oriented Architectures (SOA).

Course Outcomes: Learner will able to -

- Understand the benefits of Cloud Computing
- Learn how to provide Flexible and scalable infrastructures
- Simulate characterize the distinctions between Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS)
- Identify the concept of Public and Private Clouds, and analyze their advantages and disadvantages.

Sr. No.	Module	Detailed Content	Hours
1	System models for Distributed and Cloud Computing	Clusters of cooperative computers, Grid computing and cloud computing; software environment for advanced computing, Service oriented Architecture (SOA), Parallel and distributed programming models, Features of grid and cloud platform.	6
2	Cloud Computing services models and features	SaaS, PaaS and IaaS, Service oriented architecture and web services; Features of cloud computing architectures and simple case studies.	10
3	Virtualization	Characteristic features, Taxonomy Hypervisor, Virtualization and Cloud Computing, Pros and Cons of Cloud Computing, Technology Examples/Case Studies.	8
4	Cloud programming Environmental	Map Reduce Hadoop Library from Apache, Open Source Cloud Software Systems –Eucalyptus.	8
5	Grid Computing	Grid Architecture and Service modeling, Grid resource management, software and Middleware for grid computing, Grid Application trends.	8

6	Ubiquitous clouds and the Internet of Things	Cloud Trends in supporting Ubiquitous Computing, Enabling Technology for the Internet of Things, Innovative Applications of the Internet of Things.	8

Text Books:

1. Distributed and Cloud Computing, Kaittwang Geoffrey C.Fox and Jack J Dongrra, Elsevier India 2012.
2. Mastering Cloud Computing- Raj Kumar Buyya, Christian Vecchiola and S.Tanurai Selvi, TMH, 2012.

Reference Books:

1. Cloud Computing, John W. Ritting House and James F Ramsome, CRC Press, 2012.
2. Enterprise Cloud Computing, Gautam Shroff, Cambridge University Press, 2012.

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 `Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSE2044	**Project Management**	04	--	--	04	--	--	04
		Examination Scheme						
		Theory Examination				Term	Pract/	Total

		Internal Assessment			End Sem Exam	Work	Oral	
		Test 1	Test 2	Avg				
		20	20	20	100	--	--	100

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all	8

	stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Pract	Tut	Theory	Pract	Tut	Total

CSL201	Lab-III: Computational Laboratory on Core Courses	--	--	--	---	02	--	01
		Examination Scheme						
		Theory Examination				Term Work	Pract / Oral	
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		---	---	---	---	25	25	

Module	**Detailed Content**	**Lab Session**
High Performance Computing	Implement any two parallel algorithms(e.g. sorting, matrix- matrix multiplication) using OpenMP/MPI/OpenCL and compare their performance on CPU and GPGPU.	04
Data Science	Exploratory data analysis using Map Reduce , NoSQL, R, python and Hadoop Ecosystem Predictive data Analytics using open source tools like Rstudio, RWeka, RHadoop	04
Ethical Hacking and Digital Forensics	Operating System Forensics, Email Forensics and Mobile Forensics using open source forensics tools (e.g., Helix3pro, WinHex)	04

Assessment:

Laboratory Project: Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**	**Credits Assigned**

		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSL202	Lab-IV: Laboratory on Elective Courses	--	--	--	---	02	--	01
		Examination Scheme						
		Theory Examination				Term Work	Pract / Oral	
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		---	---	---	---	25	25	

Design and implementation of any case study/ applications based on Elective-III and Elective-IV using modern tools.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total

ME-CS301	**Special Topic Seminar**	----	06	--	---	03	--	03
ME-CS302	**Dissertation-I**	---	24	--	---	12	--	12
Total		**----**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	**Course Name**	**Examination Scheme**							
		Theory							
		Internal Assessment			**End Sem. Exam**	**Exam Duration (in Hrs)**	**TW**	**Oral/ Pract**	**Total**
		Test 1	**Test 2**	**Avg.**					
ME-CS301	**Special Topic Seminar**	---	---	---	---	---	50	50	100
ME-CS302	**Dissertation-I**	**---**	**---**	**---**	**----**	**---**	100	---	100
Total		**---**	**---**	**---**	**----**	**---**	**150**	**50**	**200**

Guidelines Special Topic Seminar:

- Seminar should be based on thrust areas in Computer Engineering/ Information Technology.
- Students should do literature survey, identify the topic of seminar and finalize it with consultation of Guide/Supervisor.
- Students should use multiple literatures (at least 10 papers from Refereed Journals/conferences) and understand the topic and research gap.
- Implementation of one paper from refereed journal as a case study.
- Compile the report in standard format and present infront of Panel of Examiners. (Pair of Internal and External examiners appointed by the University of Mumbai).
- It is advisable to students should publish at least one paper based on the work in reputed International / National Conference.

Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of 3rd semester.

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation-I

Dissertation-I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope

Dissertation-I should be assessed through a presentation by a panel of Internal examiners and external examiner appointed by the Head of the Department/Institute of respective Programme.

Course	Course Name	Teaching Scheme (Contact Hours)	Credits Assigned

Code		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CS401	**Dissertation-II**	--	30	--	---	15	--	15
Total		**--**	**30**	**--**	**---**	**15**	**--**	**13**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in			
		Test 1	Test 2	Avg.					
ME-CS401	**Dissertation-II**	--	---	---	---	---	100	100	200
Total		**--**	**---**	**---**	**---**	**---**	**100**	**100**	**200**

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution
- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/ International conference/Journal of repute.

Dissertation II should be assessed by internal and External Examiners appointed by the University of Mumbai.