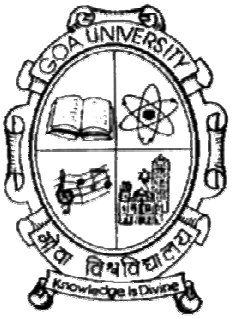
PROSPECTUS



Goa University
Master of Technology (M.Tech)
Computer Science

Academic Year 2013-14

Department of Computer Science & Technology
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Contents

Goa University

A brief introduction

Goa University was established in the year 1985 around the nucleus of the Post Graduate Centre and 17 Colleges affiliated to the Bombay University. Over the past decade, the University has grown steadily in size, and the scope of its academic programmes.

Presently the University has 12 Faculties encompassing a wide range of disciplines from Languages, Music and Art, Law, Natural Sciences, Life Sciences and Environment, Medicine, including Ayurveda, and Engineering, spread over 24 post graduate departments, 4 centres of studies, one UGC academic Staff College, 54 affiliated professional and general education colleges and institutions.

The University is located on a beautiful campus spreading over nearly 173 hectares on the Taleigao Plateau, overlooking the river Zuari joining the Arabian Sea. The Taleigao Plateau is located at a distance of 5 km from Panaji city, which is the capital of Goa. The various faculties of the University are housed in separate buildings, possessing considerable architectural distinction. The University Campus is serviced by numerous infrastructure facilities such as Hostels, Health centre, Post-office, Direct Inward Dialling, STD-ISD booths, Bank, Guest house, Kiosks and Canteens.

Hostel Accommodation

The University has full fledged hostels both for the men and women students. The hostels are located in close proximity to the Department and are well equipped with all modern facilities. There is a separate hostel for research students with limited accommodation. The students interested in seeking admission to the hostel are required to apply separately in the prescribed application form available from the respective Hostel Wardens.

Department of Computer Science and Technology (DCST)

A brief introduction

Anticipating the importance of Information Technology in present times, Goa University established the Department of Computer Science and Technology in the year 1987, with the financial assistance from DOE/UGC under the Manpower Development Scheme. A full time, 3- year degree programme leading to the “Master of Computer Applications” (MCA) degree was started in the academic year 1987-88. Goa University thus became one of the select universities of our country imparting training and education in the field of Computer Science and Application at the post graduate level.

From the academic year 2013-14, the Department enters a new phase and has decided to double student intake in its flagship MCA program and will also offer two new research programs M.Phil (Computer Science) and M.Tech (Computer Science). Presently the department has seven permanent faculty members. Additional faculty members are likely to join the department in the coming academic year. The alumni of the Department are well placed and currently hold leading positions in reputed IT organizations in the country and abroad.

Laboratory Facilities

The Laboratory facilities in the Department are constantly upgraded to cater to the growing needs of students. Currently around fifty Intel desktops spread over the Department area – the laboratory as well as faculty offices – are served by Linux and Windows servers. About fifty students can simultaneously work on MS WINDOWS/UNIX/X-Windows platforms. Presently, the laboratory supports all computer languages, Integrated Development Environments and software tools available on Open Source Linux Platform. In addition to the usual Office suites, such as Microsoft Office, the laboratory also provides students and faculty with the latest versions of development tools and application platforms such as Oracle, Visual Studio, Rational suite, IBM RSA, MATLAB and Adobe eLearning suite. The Department subscribes to the Microsoft’s MSDN Academic Initiative which provides legal copies of all Microsoft software

available on workstation and Server platforms. Legal copies of Microsoft Software including operating systems and development tools are available for students for download under MSDN Academic Licence program.

The Department rides on a Campus-wide fibre-optic backbone and has high bandwidth connectivity to the Internet. The students of the department have 24 hour access to all Internet services and laboratory infrastructure.

Library Facilities

The Goa University Library started in June 1985 with a modest collection of 37678 books. Today the University Library is fully operational in a magnificent building of its own with holdings over 1,40,000 books and subscribes to over 458 technical journals and periodicals including over fifty online journals in the field of Computer Science and Application. It houses a collection of rare books and documents and has been recognized as one of the repositories for all publications of the United Nations. A searchable online catalogue of titles in the Library as well as Abstracts of Technical articles from over 100 journals is currently available on the Campus wide network. On the subject of Computer Science alone there are over 4,000 books, technical journals and magazines. Resources from digital library of prestigious societies like Kluwer, Elsevier & Springer Verleg are now available inside the campus under INFLIBNET scheme.

Teaching Faculty

Presently the department has seven full-time faculty members. As and when necessary the department invites resource persons from prestigious institutions and industry to conduct guest lectures on the specialized topics. The list of faculty members along with their area of interest and contact details is listed below:

1. P. R. Rao, M.Sc, Ph.D
   Professor and Head
   (Theoretical Computer Science, Data mining, Data Warehousing, Information Systems Security)
   Email: pralhadrrao@gmail.com / rao@unigoa.ac.in
   Contact no: 0832-6519087/ 6519323

2. V. V. Kamat, M.Sc., M.Phil, Ph.D
   Associate Professor
   (Computer Graphics & CAD, Software Engineering, eLearning)
   Email: vvkamat@unigoa.ac.in
   Contact no: 0832- 6519072

3. Jyoti D. Pawar, B.Sc, M.C.A, Ph.D.
   Associate Professor
   (Data Structures, Data Mining)
   Email: jdp@unigoa.ac.in
   Contact no: 0832- 6519325

4. Yma F. Pinto, B.Sc., M.C.A.
   Associate Professor
   (Data Base Management Systems, Operating Systems, Computer Science Education)
   Email: yp@unigoa.ac.in
   Contact no: 0832- 6519324

5. Ramrao Wagh, B.Sc, MCA.
   Associate Professor
   (Software architecture, Object oriented Technology)
   Email: ramrao@unigoa.ac.in
   Contact no: 0832 - 6519328

6. S. Baskar, M.Sc. (Comp. Sc.)
Associate Professor
(Artificial Intelligence, Energy aware computing & Embedded Systems)
Email: baskar@unigoa.ac.in
Contact no: 0832- 6519326

7. Ramdas Karmali, B.Sc., M.C.A.
Assistant Professor
(Computer Networking, NLP)
Email: rnk@unigoa.ac.in
Contact no: 0832-6519327

Research Activity of the department

The department conducts Ph.D degree program in Computer Science. At present students have registered for the Ph.D degree in the area of Data mining, Computer Aided Design (CAD) and Natural Language Processing (NLP). The department has been sanctioned three projects by the All India Council of Technical Education (AICTE) and three project for the development of Konkani NLP tools and resources by Department of Information Technology(DIT), New Delhi. The Staff members of the department guide the students for M.Phil and B.E degree dissertation work.

The thrust areas of the department are Data Mining & Data Warehousing, Computer Graphics, Data Base Management System, Computer Networks, Software Engineering and Embedded System. The upcoming areas are Natural Language Processing and Computer Science Education.

M.Tech Programme

Course Objective

The program will prepare candidates with Bachelors Degree in Engineering and Master Degree in Science / Application for a research career either in industry or in academia.

Course Structure

M. Tech programme will consists of two years, four semesters. Semester-I and Semester-II will consist of two core and two elective papers and a seminar. Courses having lab requirement will have additional credits and it would be considered as integral part of the course. The candidate will choose electives based on the area of research interests. During Semester-III and Semester-IV candidate will work on Dissertation.

Syllabi of the core and elective course is available in Appendix-A

	First Semester				
Course code	Course Title	Lectures	Tutorial	Lab	Credits
MT 701	Combinotorics and Graph Theory	4	0	0	4
CS 702	Advanced Data Structures and Algorithms	4	0	2	6
EL-I	Elective - I	4	0	0	4
EL-II	Elective - II	4	0	0	4
	Credit Seminar I				2
	Total				20
	Second Semester				
MT 703	Stochastic Modeling and Analysis	4	0	0	4
CS 704	Machine Learning	4	0	2	6
EL-III	Elective - III	4	0	0	4
EL-IV	Elective - IV	4	0	0	4
	Credit Seminar II				2
	Total				20
	Third Semester				
	Research Progress Seminar - I				4
	Total				4
	Fourth Semester				
	Research Progress Seminar - II				4
	Dissertation & Viva				12
	Total				16
	Grand Total				60

Electives

Electives are specified under different Groups. Each Group represents area of research interest and shall contain two or more Electives. Candidates shall be allowed to choose Electives from one or more Groups.

Elective Group - I (Visual Computing)

601. Advanced Computer Graphics
602. Elements of Computational Geometry and Geometric Modelling
603. Computer Vision
604. Digital Image Processing
605. Data Visualization
606. Visual Computing

Elective Group - II (Natural Language Processing)

611. Natural Language Processing
612. Computational Linguistic
613. Speech Processing
614. Sentiment Analysis
615. Machine Translation

Elective Group - III (Educational Software)

621. Instructional Design for e-Learning
622. Educational Technology
623. Educational Game Design
624. Human Computer Interaction
625. Agile Software Engineering

Elective-IV (Big Data)

631. Distributed Databases
632. Design of Distributed Systems
633. Systems Performance and Evaluation
634. Cloud and Utility Computing
635. Data Analytics
636. Information Retrieval

Academic Calendar

The academic year shall consist of two semesters referred to as odd and even semesters. The semesters start every year in the beginning of the month of July and January and each semester is of about 16 weeks duration. Students are required to attend at least 75% of the classes held in each course/subject and actively participate in study-seminars, tutorials and laboratory work prescribed from time to time to the satisfaction of the Department. The schedule for the academic year 2013-2014 is as follows:

Odd Semester – (I, III)

Classes commence …..... 8th Jul 2013

Class Test I …..... 19th to 23rd Aug 2013

Ganesh Chathurthi break.. ..... 11th to 13th Sep 2013

Class Test II …..... 21st to 25th Oct 2013

Diwali break…….…..... 4th to 7th Nov 2013

Teaching ends…….…..... 20th Nov 2013

End – semester examination & Results..... 25th Nov to 6th Dec 2013

Even Semester – (II, IV)

Classes commence …..... 2nd Jan 2014

Supplementary examination…….... 2nd to 6th Jan 2014

Class Test I …..... 17th - 21st Feb 2014

Class Test II…..... 14th April - 19th Apr 2014

Last day of Instruction …..... 30th Apr 2014

End – semester examination & Results ..... 2nd to 16th May 2014

Instructional Scheme

Course: Master of Technology (M.Tech) Degree program is based on a system of integrated units called courses. Each course shall mean one paper.

Course Credit: One credit shall be evaluated for 25 marks. Four credit courses shall be of 100 marks. One credit is equivalent to one contact hour per week. The dissertation shall carry 16 credits.

Cumulative Credits: The sum total of all the credits of all the courses taken in a semester.

Contact Hours: A 4 credit course shall have a minimum of 45 contact hours, with 4 contact hours per week, which shall comprise of Lecture hours, Tutorial hours and Laboratory hours.

Instructor-in-Charge: Each course may have one or more instructors teaching the course. One of these is to be appointed as Instructor-in-charge.

Course Coordinator: In case of courses taught by Visiting Faculty, one faculty member from the department shall be associated with the course as Course Coordinator

Course File: For each course taught, a file shall be maintained by the Instructor-in-charge comprising of course plan, reading/teaching material used in class, assignments, question papers, answer papers, student feedback, student attendance record along with final evaluation and grading.

Academic Audit Committee: The task of the academic audit is to ascertain that all in-semester an end-semester evaluation is done in transparent and fair manner. The committee shall comprise of two members appointed by the Vice-Chancellor, one from the University Department and one expert from Industry/ Academia. It shall meet once every year end and shall examine the course file. On the basis of aberrations noticed if any, Academic Audit Committee shall take appropriate action to resolve the matter.

Scheme of Evaluation

There shall be both an in-semester element and an end-semester element in the evaluation of the performance of candidates. The in-semester evaluations shall be 60% and end-semester evaluation shall be of 40%

In in-semester evaluation, at least 40% evaluation shall be graded through one or more class tests. The remaining could be evaluated through quizzes, assignments etc.

The end-semester evaluation shall consist of an ‘end-semester’ examination of 40% evaluation conducted by the department. A candidate is eligible to appear for the end-semester examination if she/he has a minimum of 75% attendance.

For a course with lab component, the assessment will be continuous and in-semester evaluation consisting of lab experiments, assignments etc. as decided by the Instructor-in-Charge

Final grades for the course would be awarded by the Instructor-in-charge/course co-ordinator taking into account the total performance.

There shall be no revaluation. The students can make an appeal to the Chairman Departmental Council in case of any discrepancies in evaluation. The Chairman shall refer the matter to the Academic Audit Committee. The Academic Audit Committee shall also function as the Grievance Redressal Committee for the Programme.

Grading Scheme

For each course taken by a candidate, a letter grade is assigned based on the performance in all assessments. These grades are defined as:

AA, AB, BB, BC. CC, CD, DD, EE, II and FF

Each grade not only indicates a qualitative assessment of the student's performance but also carries an equivalent number called the grade point.

The grade points corresponding to different letter grades are defined below:

Letter Grade	Grade point	Letter Grade	Grade point
AA	10	CD	5
AB	9	DD	4
BB	8	EE	0
BC	7	II	0
CC	6	FF	0

A candidate passes the courses if he/she gets any grades in the range AA to DD.

The letter grade EE and the letter grade II makes the candidate eligible to take a supplementary examination in that course.

The letter grade II is given to a candidate on account of absence from the end-semester examination for valid reason.

The letter grade EE is given to a candidate on account of poor performance in the end semester examination.

The letter grade EE and II are not awarded in supplementary examination

Supplementary Examination shall be held at the beginning of every semester.

A candidate who fails in the supplementary examination is awarded FF grade and has to repeat the entire course. The candidate who fails to appear for the supplementary examination or remains absent is awarded FF and has to repeat the entire course

Candidate who fails in the Seminar or Dissertation may be allowed to re-submit the seminar report/ dissertation after incorporating suitable modifications under the guidance of the teacher.

A student shall be considered to have passed a course at first attempt, provided he/she passes with a letter grade of DD or better, at the regular examination.

In addition to the above, a student getting a letter grade of II at the regular examination and subsequently passing the course at the supplementary examination with letter grade of DD or better, will be considered to have passed the course at first attempt. However a candidate getting a letter grade of EE at the regular examination shall be deemed to get letter grade DD in the supplementary examination, if successful.

All other cases would be treated as second attempts.

Dissertation

The candidate shall be evaluated for research carried out in the 3rd & 4th semester. The evaluation shall consist of two Research Progress Seminars, Dissertation and Viva.

The Departmental Council shall decide at the beginning of the academic year the modalities relating to the dissertations. Topics for dissertations shall be finalized before the end of the first/second semester. The Departmental Council shall decide the number of candidates that a teacher can guide for the dissertation. Once the candidate decides on the topic of research, he/she shall apply in the prescribed form to the Head of the Department through the proposed guide and co-guide, as the case may be, under whose supervision he/she proposes to do research. A write-up of up to 1000 words incorporating the following points shall be enclosed with the application:

a) Title of proposed research.
b) Historical background and its present relevance
c) Research-aims and objectives

For each candidate working on the dissertation topic, a Dissertation Research Committee (DRC) shall be constituted to assess the progress of the candidate. The committee shall evaluate the progress of the candidate through Research Progress Seminar(s) for not less than 30 minutes.

The composition of the DRC will be as follows:
Guide ……...Convener
Co-guide, if applicable ……..…….. Member
Two Subject Experts…….. Member

The Subject Experts shall be nominated by the Departmental Council in consultation with the research guide. Only on obtaining pass grade in both the Research Progress Seminars, the candidate shall be allowed to write the dissertation.

At the time of submission of dissertation, the candidate shall declare, in the prescribed proforma, that the dissertation is his own work and that all the sources used by him/her are duly acknowledged.

The guiding teacher shall certify, in the prescribed proforma, that the dissertation is an original work of the candidate completed under his/her supervision.

Candidate shall submit the dissertations to the Head of the Department through the guiding teacher at the end of the fourth semester. However, he/she shall be permitted to submit the dissertation any time thereafter, upto a maximum period of four years from the initial registration.

Every candidate shall submit three copies of the dissertation to the Department in the prescribed format as under:

The size of paper: A4 (approximately 29 cm x 21 cms) except for drawings, graphs and maps, on which no restriction is placed. A margin of 2.5 cm. is to be kept on the left hand side. The front cover of the dissertation, bound in a standardized form, should contain the title of the dissertation, degree, date and name of the student concerned. The dissertation should be neatly typed in double space and only on one side of the paper.

The dissertation shall be evaluated as follows:

The dissertation shall be assessed by an external examiner to be appointed from the panel of examiners approved according to the University Ordinance OB-4.

On acceptance of the dissertation by the external examiner, a viva shall be jointly conducted by guide/supervisor and the external examiner. The presentation by the candidate shall be made before the Departmental Council members and the students for not less than 30 minutes.

A candidate who fails in the dissertation may be allowed to re-submit the dissertation after incorporating suitable modifications recommended by the examiner, under the guidance of the teacher.

Performance Indices

Semester Performance Index (SPI):

The performance of a student in a semester is indicated by a number called SPI. The SPI is the weighted average of the grade points obtained in all the courses during the semester. For example, with courses in a semester, having credits C1, C2, C3, C4 and C5 and the grade points in the semester being g1, g2, g3, g4 and g5 respectively then the SPI is equal to:

$$\mathbf{SPI} = \frac{\Sigma^{5}_{i=1}\, C_i\, g_i}{\Sigma^{5}_{i=1}\, C_i}$$

The SPI is calculated to two decimal places

Cumulative Performance Index (CPI)

The overall performance of a student for the entire programme is obtained by calculating a number called CPI. The CPI is the weighted average of the grade points obtained in all the courses for the programme. The CPI is also calculated to two decimal places.

Award of class

The class for M.Tech degree programme will be awarded according to following scheme

CPI	Class
>= 8.50	First Class with Distinction
6.50 <= x < 8.50	First Class
5.00 <= x < 6.50	Second Class
4.00 <= x < 5.00	Pass Class

There is no provision for gracing in the individual paper.

Percentage equivalent of CPI is approximately given by the formula

Percentage = 10 * CPI -5.0

Any item not covered by the programme specific Ordinances shall be governed by the University rules/regulations/ordinances in force.

Ragging

Ragging is considered a definite menace by society. Accordingly, the UGC has instructed that ragging in all forms be strictly banned by the institutions and to ensure that the campus environment be made free from ragging. All the students are strictly instructed not to indulge in ragging of any form. Strict disciplinary action will be taken against any student found guilty of ragging. The residents of the Goa University hostels are required to take special note of the above.

Further, under the Goa Prohibition of Ragging Bill 2007 strict, disciplinary action will be taken against those convicted for ragging directly or indirectly, so also those who commit, participate in abet or propagate ragging within or outside any educational institution, which may include removal from the roll of the institution for three years. Any student removed for such offense shall not be admitted in any other educational institution in the state.

Students indulging in ragging shall also be debarred from claiming scholarships or other benefits, representing in events, examinations. In case individuals committing or abetting ragging are not identified, collective punishment shall be imposed against those involved.

Head of the Department, will obtain an annual undertaking from every student stating that they have read the relevant instructions / regulations against ragging as well as punishments detailed therein.

M.Tech Admissions

Eligibility & Admission for M.Tech in Computer Science

B. E. / B. Tech. in Computer Science / Information Technology / Electronics / Electronics and Telecommunication or equivalent with 55% aggregate marks or equivalent CGPA 6.0 (50% or equivalent CGPA 5.5 for reserved category) from recognized University

OR

MCA/MSc(IT) or equivalent with 55% marks or equivalent CGPA 6.0 (50% or equivalent CGPA 5.5 for reserved category) from the faculty of Technology/ Engineering/ Science of the recognized University.

In addition, all candidates will have to undergo an Entrance Test conducted by the department in which he/she is applying. The syllabus for the Entrance Test shall be prescribed by the University from time to time. Those having a valid GATE/NET score in the subject of Computer Science/Engineering shall be exempted from the Entrance Test.

Candidates who have appeared for a degree examination and are awaiting results are also eligible to apply. In case such candidates are selected and their results are not available at the time of admission, these candidates will be given provisional admission.

Students are admitted to the M.Tech programme once a year.

Categories of Candidates for Admission

University shall admit M. Tech candidates under following categories:

a. Regular (Full-time)
These candidates shall work full time for their M. Tech. degree and may receive fellowship / assistantship from any funding agencies such as MHRD/UGC/CSIR. During the course of programme, if a regular candidate secures a job and wishes to continue in the program then he/she will be treated as a part-time candidate and he/she will have to get a No Objection Certificate (NOC) from his/her employer.

b. Sponsored (Full-time/Part-time)
The candidate in the category is sponsored by a recognized R&D organization, national institute, governmental organization, academic institute or industry for doing M.Tech in the University on a full-time /part-time basis. He/she should have relevant work experience in the respective field. Sponsorship letter (Format given in Appendix-B) should be attached with the application.

c. Project Staff (Part-time)
This category refers to candidates who are working on sponsored projects in the University and admitted to the M. Tech. program. This category of candidates shall be registered on a part-time basis.

d. University/College Faculty (Part-time)
This category refers to the candidate who is the staff of University/College affiliated to Goa University. The applicant must be a regular employee of the University/College with at least two years of experience at the time of admission and be engaged in professional work in the discipline in which admission is sought. A NOC from the College/University must be enclosed at the time of applying. This category of candidates shall be registered on a part-time basis.

Duration of the Course

Minimum four semesters spread over two academic years full-time or minimum six semesters over three academic years part-time. Maximum time allowed for a candidate to complete M.Tech programme shall be four years.

Admission Procedure

After the last date of receiving the applications, a ratio will be calculated based on the total applications received with valid GATE/NET score. This ratio shall be fixed at the beginning of the admission process and shall be utilized throughout the admission process for admitting candidates in each of the category.

Two separate merit lists shall be prepared for GATE and NET candidates under each reserved category. During the process of admission, any seat falling vacant in any reserved category shall be filled in as per the existing University rules.

If there are applications without valid GATE/NET score, the Department shall conduct a separate entrance test for such candidates based on the syllabus prescribed for GATE in the subject of Computer Science and Information Technology. (Copy of the syllabus is available in the Appendix-C). The entrance test shall be of one hour duration with 25 Multiple Choice Questions (MCQ) with negative marking. A separate merit list shall be prepared for such candidates and operated only when there are vacant seats that cannot be filled with valid GATE/NET qualified candidates.

At the most there shall be three rounds of admission and any seat falling vacant after the third round of admission shall not be filled.

Tie Breaking

In case there is a tie for a seat between candidate having valid GATE/NET score, preference will be given to NET qualified candidates with JRF/Lectureship.

In the case of candidates having equal score in the GATE/NET /Entrance Test, the candidate securing higher percentage of marks in the eligibility qualifying examination will be given priority.

Availability and Reservation of Seats

Total number seats available for admission are 10. In addition, there are 2 seats available for sponsored candidates. University shall allocate seats as per State Government/University policy. Accordingly, the distribution of seats will be as follows.

Sr.No	Category	Seats
1	OBC	2
2	SC	1
3	ST	2
4	PH	1
5	General	3
6	Other Universities	1
7	Sponsored	2
	Total Seats	12

Important Dates for Admission to the Academic Year 2013 – 2014

- Issue of Prospectus & application form ……..……...……... 4th June 2013
- Last date for receipt of completed application form …...…….. 25th June 2013 (by 4:00 P.M.)
- Entrance Test…….…….....…..... ……...…..….. 29th June 2013
- Display of merit list and waiting list …….....…..... ……...…..….. 2nd July 2013
- Last date for registration by merit list candidates…....…….…….…… 5th July 2013
- Complete First round of admissions to waiting list candidates. …….. 10th July 2013
- Complete Second round of admissions to waiting list candidates ……..…… 17th July 2013
- Final round of admission to waiting list candidates ……..……..…… 24th July 2013

For any details contact -

Admission Coordinator (M.Tech) 2013 - 2014
Department of Computer Science & Technology,
Goa University, Taleigao Plateau,
Goa 403 206.
E-mail: vvkamat@unigoa.ac.in
Ph: 6519072 / 6519272

Fee structure

For the academic year 2013-14, total fees prescribed for the Regular Candidate is Rs. 35,750/- per year and for the sponsored candidates it is double i.e. Rs. 71,500/- per year.

For students requiring hostel accommodation, the University has full fledged hostels both for the men and women students.

Hostel Fees	**Amount (in Rs.)**
Per Semester	2,150
Deposit (Refundable)	3,000
Total fees	**5,150**

Hostel Mess charges would be approximately Rs. 1500/- per month

Refund of Fees

1. In the event of a student withdrawing before the last day of admission (24th July 2013), and if the seat consequently falling vacant has been filled by another candidate by the last day of admission the entire fee collected from the student, after a deduction of the processing fee of Rs. 1000/- (one thousand only) shall be refunded.

2. No refund of fee is admissible if the student withdraws admission on the last date (24th July 2013) or later. The above rule shall be applicable to all items of fee except refundable deposits.

3. All other cases of refund of fees will be decided on case to case basis, based on its merit.

APPENDIX A
DETAILED SYLLABUS
(CORE COURSES)

Course: MT 701Combinotorics and Graph Theory
Course Prerequisites: First level course on Discrete Mathematics.
Course Objectives: Combinatorics and Graph Theory is one of the areas of mathematics that every computer science student should be familiar with. Most of the algorithms used in computer science are combinatorial in nature and are often based on graph theory concepts.
The intension of this course is to introduce the subject of Combinatorics and Graph Theory in a thorough way.

Course Contents: Graph, Sub Graph, Connected component , spanning trees , Shortest path algorithm, Cut-sets and Cut-Vertices: Cut-Sets, Properties of Cut-sets, All Cut-sets in a Graph, Fundamental Circuits and Cut-Sets, Connectivity and Separability, Network flows, 1-isomorphism, 2-isomorphism. Combinatorial Vs. Geometric Graphs, Planar Graphs, Kuratowski's Two Graphs, Different Representations of a Planar Graph, Detection of planarity, Geometric Dual, Combinatorial Dual, Matrix Representation of Graphs.

Chromatic Number, Chromatic Partitioning, Chromatic, Polynomial, Vertex Cover, Matchings, Pathcover, Connectivity, Hamiltonicity, Vertex Coloring, Edge Coloring, Four Color Problem and Other Coloring Problems.

Basic combinatorial numbers, recurrences, generating functions, Latin squares, partitions, partially orders sets, Types of Enumeration, Counting Labeled Trees, Counting Unlabeled Trees, Polya's Counting Theorem, Graph Enumeration with Polya's Theorem.

Main Reading:
1. Graph Theory with Applications to Engineering and Computer Science, Narasingh Deo, PHI.

Additional References:
1. Graph Theory and Combinatorics, Dr. D.S. Chandrasekharaiah, Prism, 2005.
2. Introduction to Graph Theory, Chartrand Zhang, TMH, 2006.
3. Graph Theory Modeling, Applications, and Algorithms, Geir Agnarsson & Raymond Geenlaw,Pearson Prentice Hall, 2007.
4. A Walk Through Combinatorics by Miklos Bona, World Scientific Publishing Company June 15, 2002.
5. Concrete Mathematics: A Foundation for Computer Science, by Ronald Graham, Donald Knuth, and Oren Patashnik.
6. A Course in Combinatorics, J. H. van Lint, R. M. Wilson Cambridge University Press January 29, 1993.
7. Combinatorial Methods with Computer Applications Jonathan L. Gross.
8. Graph Theory and Its Applications, Second Edition Jonathan L. Gross, Jay Yellen.

Course: CS 702 Advanced Data Structures & Algorithms
Course Prerequisites: First level course on Data Structures and Algorithms is desirable.
Course Objectives: To study efficient algorithms for a number of fundamental problems, learn techniques for designing algorithms using appropriate data structures.

Course Contents: Revision of Algorithm Analysis: Mathematical Background, Big-O notation, Running Time computation, different strategies of algorithm design – Divide and Conquer, Greedy, Dynamic Programming etc.

Amortized complexity, Introduction to external sorting, Selection trees & k-way merging, Double-ended priority queues, Interval heaps. Leftist trees, Binomial heaps, Fibonacci heaps, Fibonacci Analysis, Pairing heaps.

Dictionaries, Optimal Binary Search Trees, AVL trees, Red-black trees, B-trees, B*-trees. Splay trees, Binary Tries, Compressed Binary Tries. Tries and Packet Forwarding, High-order Tries, Suffix Trees,

Bloom Filters, Segment Trees, Interval Trees, Priority Search Trees, Multidimensional Search Trees, k-d Trees, Quad Trees, BSP Trees, R-Trees.

Revision of basic graph traversal and search technique, Backtracking, Branch and Bound, NP-Hard and NP-Complete problems.

Approximation algorithms Vertex Cover, Set Cover, TSP.

Randomized Algorithms, Expected v/s Average time, pseudorandom generation, Numerical probabilistic algorithms, Monte Carlo algorithms, Las Vegas algorithms.

Main Reading:

1. Data Structures, Algorithms, and Applications in C++, McGraw Hill, NY, 2005 2nd ed.
2. Algorithm Design, Jon Kleinberg , Eva Tardos, Pearson
3. T. H Cormen, C.E. Leiserson, R. L. Rivest, C. Stein, "Introduction to Algorithms ", Prentice Hall of India, 2001.

Additional References:

1. Fundamentals of Computer Algorithms 2nd ed. Horowitz, Sahni and Rajasekaran University Press
2. Fundamentals of Data Computer Algorithms
3. G. Brassard and Bratley, Fundamentals of Algorithmic, Prentice. Hall 1996.
4. Michael Garey and David Johnson, Computers and Intractability, A guide to the theory of NP-Completeness, W.H. Freeman and Company, New York, 1999

Course: MT 703 Stochastic Modeling and Analysis

Course Prerequisites: First level course on Probability & Statistics.

Course Objectives: An introduction to probability theory and stochastic models, as they apply to computer science. Key terms are random variables, probability distributions, sampling theory, random samples, etc. It will also consider Markov chains, a particular stochastic process that is frequently applied in stochastic modeling of computer and communication systems.

Course Contents: Probability Preliminary: Axiomatic approach of probability, Random variable-characteristics- mean, Variance, distribution function, E and V- operators, moment generating function (MGF) and characteristic function, function of multi-dimensional random variable.

Probability distributions: Discrete distributions: Binomial, Pascal, and Poisson- establishment and analysis Continuous distributions: Exponential, normal, lognormal, gamma and Weibull distributions and analysis-properties and limiting form, approximations.

Sampling Theory, Random Samples, Sampling Distributions, Estimation of parameters, Test of hypotheses on the Mean, Type I error, Type II Error, Test of Hypothesis on the equality of Two Means, Test of Hypothesis on a variance, Test of Hypothesis on the Equality of Two variances, Goodness of fit test

Pure birth process, Assumptions, derivation; birth and death queuing models- single and multiple Server queuing models- queues with finite waiting- finite source models, steady state measures Markov Chains – Introduction, Transition Probabilities, Homogeneous Markov Chains, Transition Probability Matrix, Initial Distribution, Absorbing States, Communication between States, Irreducible Markov Chains, Steady State Vector. Limitations of Markov process, Semi-Markov chains- establishment, transformation, system effectiveness prediction, Hidden Markov models (conceptual treatment) with selected applications restricted to Engg.

Main Reading:

1. William W. Hines & Doughlas C. Montgomery (2002), Probability and statistics in Engg and management science, John Wiley & Sons, 4th edition.
2. Kishor S. Trivedi (2000), Probability and Statistics with Reliability, Queuing and Computer Science Applications, Prentice Hall of India.
3. Sheldon M. Ross (2007), Introduction to Stochastic processes, Academic Press, USA, 9th edition.

Course Code: CS 704 Machine Learning
Course Prerequisites: First Course on Probability & Statistics.
Course Objectives: This course provides a broad introduction to machine learning and statistical pattern recognition.

Course Contents: Overview and Introduction to Bayes Decision Theory: Machine Intelligence and Applications, Pattern Recognition concepts, Classification, Regression, Feature Selection, Supervised Learning, Class conditional probability distributions, Examples of classifiers, Bayes optimal classifier and error, Learning classification approaches.

Linear machines: General and Linear Discriminants, Decision regions, Single layer neural network, Linear separability, general position, number of dichotomies, General gradient descent, Perceptron learning algorithm Mean square criterion and Widrow-Hoff learning algorithm.

Multi-Layer Perceptrons: Introduction to Neural Networks, Two-Layers Universal approximators, Backpropagation learning, on-line, off-line Error surface, important parameters.

Learning decision trees: Inference model, general domains, symbolic, Decision trees, consistency, Learning trees from training examples Entropy, mutual information, ID3 algorithm criterion, C4.5 algorithm, Continuous test nodes, confidence, Pruning, Learning with incomplete data.

Instance-based Learning: Nearest neighbor classification, k-Nearest neighbor, Nearest Neighbor error probability, proof Simplification, Editing Example: Document retrieval, Case-based reasoning Example: learning graphical structures.

Machine learning concepts and limitations: Fundamental algorithmic-independent concepts, Hypothesis class, Target class, Inductive bias, Occam's razor, Empirical risk, Limitations of inference machines, Approximation and estimation errors, Tradeoff

Machine learning assessment and Improvement: Statistical Model Selection, Structural Risk Minimization, Practical methods for risk assessment based on re-sampling, Jackknife, Bootstrap, Improving accuracy of general algorithms, Bagging, Boosting.

Learning Theory: Formal model of the learnable, Sample complexity, Learning in zero-Bayes and realizable case, Growth function, VC-dimension, VC-dimension of Vector space of functions, proof, Empirical Risk Minimization over finite classes, sample complexity, proof, Empirical Risk Minimization over infinite classes, risk upper bound, proof Lower bound on sample complexity

Support Vector Machines: Margin of a classifier, Dual Perceptron algorithm, Learning non-linear hypotheses with perceptron, Kernel functions, implicit non-linear feature space, Theory: zero-Bayes, realizable infinite hypothesis class, finite covering, margin-based bounds on risk, Maximal Margin classifier, Learning support vector machines as a dual-optimization problem.

Unsupervised learning: Clustering, K-means, EM. Mixture of Gaussians, Factor analysis, PCA (Principal components analysis), ICA (Independent components analysis)

Reinforcement learning and control: MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), LQG, Q-learning, Value function approximation, Policy search. Reinforce, POMDPs.

Main Reading:
1. The Elements of Statistical Learning: Data Mining, Inference and Prediction, Hastie.T, Tibshirani.R., and Friedman.J. Springer [2001].

Additional References:
1. Pattern Classification, Duda.R.O., Hart.P.E., and Stork.D.G, John Wiley and Sons (2001).
2. Pattern Recognition and Machine Learning, Bishop, Christopher M., Springer (2006).
3. An Introduction to Support Vector Machines, Shawe-Taylor J. and Cristianini N., Cambridge University Press (2000).

4. Kernel Methods for Pattern Analysis, Shawe-Taylor.J, and Cristianini N., Cambridge University Press (2004).

DETAILED SYLLABUS
(ELECTIVE COURSES)

601- Advanced Computer Graphics

Course Prerequisites: Knowledge of computer graphics fundamentals and ability to program in C/C++.
Course Objectives: This course will study advanced topics in computer graphics. The focus will be on learning recent methods in rendering, modeling, and animation.

Course Contents: Rendering concepts, lighting, reflectance, Global Illumination, rendering equation, Monte Carlo Path Tracing, Radiosity, form factors, solution methods, meshing

Visibility & Textures: Visibility events, discontinuity meshing, texture mapping, resampling

Image-Based Modeling and Rendering: Managing Scene Complexity, Occlusion culling, detail elision, imposters, plenoptic function, image-based representations

3D Modeling: Object Representations, Mesh Representations,: mesh data structures, simplification, Triangle meshes, Multi-resolution meshes, progressive meshes, view-dependent simplification, Mesh Processing, Compression, streaming

Surface Modeling: Parametric surfaces, splines, piecewise polynomial surfaces, Subdivision of surfaces, subdivision schemes

Volumetric Modeling: Implicit surfaces, blobby models, skeletons, variational implicit surfaces, Volumetric Representations, voxels, volume graphics

Kinematics: Articulated figures, inverse kinematics, space-time constraints, Motion Capture, processing motion capture data, retargeting motion

Dynamics: Passive Dynamics, particle systems, spring-mass systems, Active Dynamics, controllers, learning, planning

Main Reading:

1. Alan Watt and Mark Watt, Advanced Animation and Rendering Techniques: Theory and Practice, Addison-Wesley,

Additional References:

1. Tom McReynolds and David Blythe, Advanced Graphics Programming using OpenGL, Elsevier
2. Peter Shirley and Steve Marschner and other, Computer Graphics, Cengage Learning
3. T. Theoharis, G. Papaioannou, N. Platis and N. Patrikalakis, Graphics and Visualization, A K Peters.

Website Links:
http://www.cs.princeton.edu/courses/archive/fall02/cs526/

602 - Elements of Computational Geometry and Geometric Modeling

Course Prerequisites: Algorithms & Data Structures.
Course Objectives: This course will cover topics in 2D and 3D geometry and its transformations, differential geometry of curves and surfaces, 3D geometry and coordinate transformations, curves and surface design, solid modeling, meshing and computational geometry data structures and algorithms.

Course Contents: Basics in 2D and 3D geometry and transformations: Plane co-ordinate geometry, equations of lines and plane curves, parametric equations of lines and curves, intersection of parametric lines and curves, polar coordinates, vector representation of a point, line, plane, curve, continuity, tangent and curvature

Differential Geometry of curves and surfaces: Arc length and tangent vector, Principal normal and curvature, Binomial vector and torsion, Frenet-Serret formulae, tangent plane and surface normal, first fundamental form, second fundamental form, principal curvatures, Gaussian and mean curvature, Euler's theorem and Dupin's indicatrix

3D Geometry and Coordinate Transformations: Translation, rotation about arbitrary axis, scaling, reflection, shear and composite transformation, homogenous coordinates, projections parallel and perspective, taxonomy of projections

Curves and surface design: Parametric space of curves, blending functions, Spline curves, Bezier curves, B-Spline curves, rational polynomials, cylindrical surface, rules surface, surface of revolution, conic surfaces, composite surfaces, Bezier surface, B-spline surface

Solid modeling: Parametric space of solid, topology of closed path, piecewise flat surfaces, topology of closed curved surfaces, generalized concept of a boundary, set theory, Boolean operation operators, Euler operators, solid modeling representations cell decomposition and spatial occupancy enumeration, sweep representation, CSG

Meshes: Polygonal mesh representation, Basic mesh descriptions, Mesh topology, Triangulations and Tessellations, Winged edge data structures for meshes, Operations on meshes like Fairing, Smoothing, Remeshing etc.

Computational geometry data structures and algorithms: Line segment intersection, orthogonal range searching, Voronoi diagrams and Delaunay triangulations, convex hull, Quadtree, orthogonal range searching kD-tree, and binary space partitioning

Main Reading:

1. Patrikalakis, N. M., T. Maekawa, and W. Cho. Shape Interrogation for Computer Aided Design and Manufacturing. New York, NY: Springer Verlag, 2010.

Additional References:

1. de Berg, van Kreveld, Overmars, and Schwarzkopf. Computational Geometry: Algorithms and Applications,' by (2nd ed, Springer Verlag, 2000).
2. Farin, G. E. Curves and Surfaces for Computer Aided Geometric Design. 3rd ed. Academic Press, 1993.
3. Faux, I. D., and M. Pratt. Computational Geometry for Design and Manufacture. Halsted Press,1979.
4. Lawrence, J. D. A Catalog of Special Plane Curves. Dover, 1972.
5. Mortensen, M. E. Geometric Modeling. J. Wiley, 1985.
6. Mantyla M. An Introduction to Solid Modeling, Computer Science Press, 1988.

603 - Computer Vision

Course Prerequisites: Machine Learning

Course Objectives: To be able to understand and apply a series of probabilistic models of images and objects in computer vision systems.

Course Contents: Two-dimensional visual geometry: 2D transformation family, Homography, Estimating 2D transformations, Image panoramas

3D image geometry: The projective camera, Camera calibration, recovering pose to a plane

Multiple Cameras: The fundamental and essential matrices, Sparse stereo methods, Rectification, Building 3D models, Shape from silhouette

Vision at a single pixel: Background subtraction and color segmentations problems, Parametric, non-parametric and semi-parametric techniques, Fitting models with hidden variables

Connecting pixels: Dynamic programming for stereo vision, Markov random fields, MCMC methods, Graph cuts

Texture: Texture synthesis, super-resolution and denoising, image inpainting The epitome of an image

Dense Object Recognition: Modelling covariances of pixel regions, Factor analysis and principle components analysis

Sparse Object Recognition: Bag of words, latent dirilecht allocation, probabilistic latent semantic analysis

Face Recognition: Probabilistic approaches to identity recognition, Face recognition in disparate viewing conditions

Shape Analysis: Point distribution models, active shape models, active appearance models

Tracking: The Kalman filter, the Condensation algorithm

Main Reading:

1. Computer Vision: Models, Learning, and Inference, Simon J.D. Prince, Cambridge University Press

Additional References:

1. Computer vision: algorithms and applications by Richard Szeliski.
2. Bayesian reasoning and machine learning by David Barber
3. Multiple view geometry in computer vision by Richard Hartley and Andrew Zisserman
4. Information theory, inference and learning algorithms by David MacKay
5. Feature extraction and image processing by Mark S. Nixon and Alberto S. Aguado
6. Pattern recognition and machine learning by Christopher M. Bishop

604 - Digital Image Processing

Course Prerequisites: - C/C++ programming skills

Course Objectives: The course will cover techniques and tools for digital image processing, and finally also introduce image analysis techniques in the form of image segmentation.

Course Contents:Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, sampling and quantization.

Spatial Domain Filtering: Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian

Filtering in the Frequency domain: Hotelling Transform, Fourier Transforms and properties, FFT (Decimation in Frequency and Decimation in Time Techniques), Convolution, Correlation, 2-D sampling, Discrete Cosine Transform, Frequency domain filtering

Image Restoration: Basic Framework, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections

Image Compression: Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem, Huffman Coding, Arithmetic Coding, Golomb Coding, LZW coding, Transform Coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length coding, FAX compression (CCITT Group-3 and Group-4), Symbol-based coding, JBIG-2, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation

Wavelet based Image Compression: Expansion of functions, Multi-resolution analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform, JPEG-2000 encoding, Digital Image Watermarking.

Morphological Image Processing: Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.

Image Segmentation
Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation

Main Reading: -

1. Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods Publisher: Pearson Education.

Additional References: -

1. Fundamentals of Digital Image Processing By Anil K Jain.

Website Links: http://www.ece.arizona.edu/~dial/

605 - Data Visualization
Course Prerequisites: - C/C++ programming skills
Course Objectives: To study important approaches in the field of Data Visualization and its techniques.

Course Contents: What is Visualization, the visualization process, Data Foundations, types of data – continuous data, sampled data, discrete datasets, Human Perception and Information Processing, Visualization Foundations

Visualization Techniques for Spatial Data: 1D, 2D and 3D, Dynamic Data, Geospatial Data, Visualizing Point, Line and Area Data, Visualization Techniques for Multivariate Data, Visualization Pipeline

Visualization Techniques Graphs, Text and Document: Visualizing Trees, Graphs, and Networks, Displaying Hierarchical Structures, Arbitrary Graphs/Network, Levels of Text Representation, the Vector Space Model, Single Document Visualization, Document Collection Visualization,

Scientific Visualization: Scalar, Vector, Tensor Visualization, Domain Modeling Technique, Image and Volume Visualization

Interaction Concepts: Interaction Operators, Operands and Spaces, Interaction Techniques – Screen Space/Object Space, Data Space, Attribute Space, Animating Transformations, Designing Effective Visualizations Comparing and Evaluating Visualization Techniques, Visualization Systems

Main Reading:

1. Mathew Ward, Georges Grinstein, Daniel Keim, Intercative Data Visualization Foundation, Techniques and Applications, A K Peters 2010

Additional References:

1. Alexandru Telea, Data Visualization Principles and Practices, A K Peters 2010
2. Visualization Design and Analysis: Abstractions, Principles, and Methods by Tamara Munzner.

606 - Visual Computing
Course Prerequisites: - C/C++ programming skills
Course Objectives: The recent advances in the field of Visual Computing thrives on inputs from multiple disciplines, which are traditionally taught in separate courses in the University such as Computer Graphics, Computer Vision and Image Processing. This course on Visual Computing will attempt to provide a unified perspective to the underlying algorithms and data structure involved in modeling shape of the objects, its interactions with the light source in synthesizing imagery and retrieving 3D information from 2D images.

Course Contents: Overview of Visual Computing: Visual computing and its relationship to traditional discipline like Computer Graphics, Computer Vision, Image Processing and Computational Geometry

Image synthesis: Understand the concepts - Captured image in 2D v/s synthesized image via modeling & rendering. Capturing of 3D data using scanning technology and reverse engineering the shape of the object

Geometric modeling: Data structures for object representation, Volume representation, Sweep representation, Cell decomposition, CSG, Boundary representation, Euler Operators, Beizier & B-Spline curves and surfaces

Meshes: Polygonal mesh representation, Basic mesh descriptions, Mesh topology, Triangulations and Tessellations, Winged edge data structures for meshes, Operations on meshes like Fairing, Smoothing, Remeshing etc.

Coordinate pipeline: Transformation principles, Geometry pipeline, Graphics pipeline, Vision pipeline, Advanced Coordinate pipeline

Image geometry: Sampling and Quantization, Region and edges, Image filtering, Edge detection, Contours, Textures, Warping and morphing of images, Interpolations, Colors, Half-toning and Dithering, High-dynamic range imaging, Image pyramids

Motion capture:Motion tracking, randomized incremental algorithms, computational geometry algorithms Delaunay triangulations, Voronoi diagrams, kD-trees, Clustering by kMeans

Main Reading:

1. Visual Computing: Geometry, Graphics and Vision by Frank Nielsen

Additional References:

1. Computer vision: algorithms and applications by Richard Szeliski.
2. Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods Publisher: Pearson Education

611 - Natural Language Processing

Course Prerequisites:

1. A previous course on Artificial Intelligence will help.
2. Courses of Data Structures and Algorithms should have been done.
3. Exposure to Linguistics is useful, though not mandatory.

Course Objectives: To study fundamental concepts of Natural Language Processing and to introduce the basics of Language processing from algorithmic viewpoint.

Course Contents: Introduction, Machine Learning and NLP, ArgMax Computation, Word Sense Disambiguation: WordNet, Wordnet; Application in Query Expansion, Measures of WordNet Similarity.

Resnick's work on WordNet Similarity, Parsing Algorithms, Evidence for Deeper Structure; Top Down Parsing Algorithms, Noun Structure; Top Down Parsing Algorithms, Non-noun Structure and Parsing Algorithms.

Probabilistic parsing; Sequence labelling, PCFG, Probabilistic parsing: Training issues, Arguments and Adjuncts, Probabilistic parsing; inside-outside probabilities.

Speech : Phonetics, Hidden Markov Model, Morphology, Graphical Models for Sequence Labelling in NLP, Consonants (place and manner of articulation) and Vowels.

Forward Backward probability; Viterbi Algorithm, Phonology, Sentiment Analysis and Opinions on the Web, Machine Translation and MT Tools - GIZA++ and Moses, Text Alignment, POS Tagging.

Phonology; ASR, Speech Synthesis, Hidden Markov Model and Viterbi, Precision, Recall , F-score, Map, Semantic Relations; UNL; Towards Dependency Parsing.

Universal Networking Language, Semantic Role Extraction, Baum Welch Algorithm; HMM training.

Main Reading:

1. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
2. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.
3. Jurafsky, Dan and Martin, James, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
4. Manning, Christopher and Heinrich, Schutze, Foundations of Statistical
5. Natural Language Processing, MIT Press, 1999.

Additional References:

1. Radford, Andrew et. al .,Linguistics, An Introduction, Cambridge University Press, 1999.
2. Journals: Computational Linguistics, Natural Language Engineering, Machine Learning, Machine, Translation, Artificial Intelligence.
3. Conferences: Annual Meeting of the Association of Computational Linguistics (ACL), Computational Linguistics(COLING), European ACL (EACL), Empirical Methods in NLP (EMNLP), Annual Meeting of the Special Interest Group in Information Retrieval (SIGIR), Human Language Technology (HLT), International Conference on Natural Language Processing (ICON).

Website Links: http://nptel.iitm.ac.in/courses/106101007/

612 - Computational Linguistics

Course Prerequisites:

1. A previous course on Artificial Intelligence will help.
2. Courses on Natural Language Processing should have been done.
3. Exposure to Linguistics is useful, though not mandatory.

Course Objectives: To introduce the advanced concepts in computational linguistics, modern grammar formalisms, Natural Language generation, etc.

Course Contents: Tree Adjoining Grammars-Dependency Grammars-Statistical Parsing-Introduction to Semantic Processing-Semantic Knowledge Representation, Deep Structure and Logical Form-Compositional Semantic Interpretation-Semantic Grammars-Case Frames and Case Frame based Parsing.

Natural Language Generation-Problems in NL Generation-Basic Generation Techniques Hard Problems in NLP-Speech Understanding and Translation-Discourse Processing.

Lexical Functional Grammar: Active-Passive and Dative Constructions-Wh-movement in Questions-Overview of LFG-LFG Formalism-Well-formedness Conditions-Handling Wh movement in Questions-Computational Aspects.

Morphology and Finite State Transducers-Inflectional Morphology-Derivational Morphology-Finite State Morphological Parsing-The Lexicon and Morphotactics Morphological Parsing with Finite State Transducers-Orthographic Rules and Finite-State Transducers-Combining an FST Lexicon and Rules-Lexicon-Free FSTs.

Main Reading:

1. Alexander Clark, Chris Fox, and Shalom Lappin (Editors):The Handbook of Computational Linguistics and Natural Language Processing (Blackwell Handbooks in Linguistics).
2. Akshar Bharathi, Vineet Chaitanya, and Rajeev Sangal: Natural Language Processing: A Paninian Perspective. Prentice Hall of India.
3. James Allen: Natural Language Understanding. Benjamin/ Cummins.

Additional References:

1. Journals: Computational Linguistics, Natural Language Engineering, Machine Learning, Machine, Translation, Artificial Intelligence.

2. Conferences: Annual Meeting of the Association of Computational Linguistics (ACL), Computational Linguistics(COLING), European ACL (EACL), Empirical Methods in NLP (EMNLP), Annual Meeting of the Special Interest Group in Information Retrieval (SIGIR), Human Language Technology (HLT), International Conference on Natural Language Processing (ICON).

613 - Speech Processing

Course Prerequisites:

1. A previous course on Artificial Intelligence will help.
2. Courses of Data Communication and Digital Signal Processing should have been done.

Course Objectives: To study the fundamental concepts of Speech processing.

Course Contents: Anatomy & Physiology of Speech Organs, The process of Speech Production, The Acoustic Theory of Speech Production, Digital models for speech signals.

Introduction, Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech vs. silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.

Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, Pitch Detection and using LPC Parameters.

Introduction, Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, The Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, Mel frequency cepstrum computation.

Nature of interfering sounds, Speech enhancement techniques: spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter.

Basic pattern recognition approaches, Parametric representation of speech, Evaluating the similarity of speech patterns, Isolated digit Recognition System, Continuous digit Recognition System.

Hidden Markov Model (HMM) for speech recognition, Viterbi algorithm, Training and testing using HMMs, Adapting to variability in speech (DTW), Language models.

Issues in speaker recognition and speech synthesis of different speakers. Text to speech conversion, Calculating acoustic parameters, synthesized speech output performance and characteristics of text to speech, Voice processing hardware and software architectures.

Main Reading:

1. Digital processing of speech signals - L.R Rabiner and S.W. Schafer. Pearson Education.
2. Speech Communications: Human & Machine - Douglas O'Shaughnessy, 2nd ed., IEEE Press.
3. Fundamentals of Speech Recognition. L.R Rabinar and B.H. Juang.

Additional References:

1. Discrete Time Speech Signal Processing: Principles and Practice - Thomas F. Quateri 1st ed., PE.
2. Speech & Audio Signal Processing- Ben Gold & Nelson Morgan, 1 ed., Wiley.
3. Speech Recognition - Claudio Becchetti and Lucio Prina Ricotti, Wiley

614 - Sentiment analysis

Course Prerequisites: A previous course on Artificial Intelligence and Natural Language Processing will help.

Course Objectives: The objective is to study concepts of Sentiment analysis and opinion mining. Sentiment analysis and opinion mining is the field of study that analyzes people's opinions, sentiments, evaluations, attitudes, and emotions from written language. It is one of the most active research areas in natural language processing and is also widely studied in data mining, Web mining, and text mining.

Course Contents: Sentiment Analysis Applications, Sentiment Analysis Research, Sentiment Analysis Research, and Opinion Spam Detection.
Problem of Sentiment Analysis: Problem Definitions, Opinion Summarization, Different Types of Opinions, Subjectivity and Emotion, Author and Reader Standing Point.

Sentiment Classification Using Supervised Learning, Sentiment Classification Using Unsupervised Learning, Sentiment Rating Prediction, Cross-Domain Sentiment Classification, Cross-Language Sentiment Classification
Sentence Subjectivity: Subjectivity Classification, Sentiment Classification, Dealing with Conditional Sentences, Dealing with Sarcastic Sentences, Cross-language Subjectivity and Sentiment Classification, Using Discourse Information for Sentiment Classification.

Basic Rules of Opinions and Compositional Semantics, Aspect Extraction, Identifying Resource Usage Aspect, Simultaneous Opinion Lexicon Expansion and Aspect Extraction, Grouping Aspects into Categories, Entity, Opinion Holder and Time Extraction, Word Sense Disambiguation.

Problem Definitions, Identify Comparative Sentences, Identifying Preferred Entities.

Web Search vs. Opinion Search, Existing Opinion Retrieval Techniques

Types of Spam and Spamming, Supervised Spam Detection, Unsupervised Spam Detection, Group Spam Detection.

Quality as Regression Problem, Other Methods.

Main Reading:
1. Sentiment Analysis and Opinion Mining, Bing Liu.

Additional References:
1. Journals: Computational Linguistics, Natural Language Engineering, Artificial Intelligence.
2. Conferences: Annual Meeting of the Association of Computational Linguistics (ACL), Computational Linguistics(COLING), European ACL (EACL), Empirical Methods in NLP (EMNLP), Human Language Technology (HLT), International Conference on Natural Language Processing (ICON).

615 - Machine Translation
Course Prerequisites:
1. A previous course on Artificial Intelligence and Natural Language Processing will help.
2. Knowledge on Machine Learning.
3. Exposure to Linguistics is useful, though not mandatory.

Course Objectives: To study important approaches to the automatic translation between natural languages.

Course Contents: History-Translation process-Approaches-Rule-based-Statistical-Example based-Hybrid MT Major issues-Disambiguation-Named entities-Applications-Evaluation.

Language Similarities and Differences-The Transfer Metaphor-Syntactic Transformations Lexical Transfer.

The Interlingua Idea: Using Meaning-Direct Translation-Using Statistical Techniques Quantifying Fluency-Quantifying Faithfulness.

Statistical MT-Basis-Benefits-Word based translation-Phrase based translation- Syntax based translation-Challenges with statistical machine translation-Compound words- Idioms Morphology-Different word orders-Syntax-Out of vocabulary (OOV) words.

Main Reading:
1. Hutchins, W.John; and Harold L. Somers. An Introduction to Machine Translation London: Academic Press. 1992.
2. Allen, James: Natural Language Understanding. Benjamin/Cummins. 1995.

3. C.D. Manning and H. Schutze: Foundations of Statistical Natural Language Processing, MIT Press 2001.

Additional References:

1. Journals: Machine Learning, Machine, Translation, Artificial Intelligence.
2. Conferences: The Association for Machine Translation in the Americas(AMTA), Annual Meeting of the Association of Computational Linguistics (ACL), Computational Linguistics(COLING), International Conference on Natural Language Processing (ICON).

Website Links: http://www.statmt.org/

621 - Instructional Design for e-Learning
Course Objectives:

1. Apply the Understanding by Design framework to course design.
2. Investigate modern computer-based design tools.
3. Explore instructional methods and principles of design

Course Contents: Personal Learning Environments, Instructional Design Foundations, Learning Outcomes Assessment
Content Creation: graphics
Cognitive Load Theory
Content Creation: audio and podcasting
Evaluation of Tools and Methods
Content Creation: video
Learning Management Systems, Designing for Accessibility
Content Creation: web-based tools

Main Reading:

1. Dick, W., Carey, L., & Carey, J. O. (2009). The systematic design of instruction (7th ed.). Boston: Allyn and Bacon.
2. Wiggins, G. P., & McTighe, J. (2005). Understanding by design (2nd ed., p. 370). Alexandria, VA: Association for Supervision and Curriculum Development.
3. Christensen, C. M., Horn, M. B., & Johnson, C. W. (2008). Disrupting class: How disruptive innovation will change the way the world learns. New York: McGraw-Hill.

622- Educational Technology

Course Objectives: This course is an introduction to the classroom applications of educational technologies. The course includes a survey of educational hardware and software.

Course Contents: Technology in Education: Meaning, Evolution and Development

Traditional Educational Technology/Materials: Cone of Experiences: Direct and Purposeful (Games & Experiments), Contrived Experiences (Three Dimensional, Mock up, Diorama), Dramatized Experiences(Pageant, Socio-Drama), Demonstration Boards (chalkboard, peg board etc.), Field Trips, Exhibits, Still Pictures(drawings, graphs, cartoon, etc.)

Trends in Educational Technology: Projected materials, Audio Materials, Interactive Materials

ICT in Education: Computer, Internet, Multimedia/Hypermedia

Educational Technology in Instructional Planning: Multiple Intelligence, Learning Styles, Blooms Taxonomy

Technology and Student Assessment: Rubrics, Checklist, Blogs

Main Reading:

1. Teachers Discovering Computers, Integrating Technology in the Classroom, Second Edition by Shelly Cashman Gunter, (ISBN: 0-7895-6492-0).

2. Integrating Educational Technology into Teaching, Student Value Edition (6th Edition), M. D. Roblyer, Aaron H. Doering, Publisher: Pearson; 6 edition (February 25, 2012) ISBN-10: 013289680X, ISBN-13: 978-0132896801.

623 - Educational Game Design
Course Objectives: Understand Game design and to apply it for e-Learning.

Course Contents: What is Gamification? : Introduction, Gamification defined, Why study gamification? History of gamification, Categories and examples

Games: Gamification in context, What is a game? Games and Play, Video games

Game Thinking: Why Gamify, Thinking Like a Game Designer, Design rules, Tapping the Emotions, Anatomy of Fun, Finding the Fun

Game Elements: Breaking Games Down, The pyramid of elements, The PBL Triad, Limitation of Elements, Bing Gordon interview

Psychology and Motivation: I: Behaviorism :-Gamification as motivational design, Behaviorism, Behaviorism in gamification, Reward structures, Reward schedules; Beyond Behaviorism :- Limits of behaviorism, Dangers of behaviorism, Extrinsic and intrinsic rewards, How rewards can de-motivate, Self-determination theory

Gamification Design Framework: Design Thinking, Business objectives/target behaviors, Players, Activity loops, Don't forget the fun and deploy

Design Choices: Two approaches to gamification, Is Gamification right for me?, Designing for collective good, Designing for happiness

Applying gamification for learning domains: declarative knowledge, conceptual knowledge, rules-based knowledge, procedural knowledge, soft skills, affetve domain, psychomotor domain
Social Good and Behavior Change: Gamification for good? Social good applications, Social good techniques, Behavior change

Critiques and Risks: Pointsification, Exploitationware, Gaming the game, Legal issues, Regulatory issues

Beyond the Basics: Going beyond the basics, Inducement prizes, Virtual economies, Collective action, The future of gamification

Main Reading:
1. For the Win: How Game Thinking Can Revolutionize Your Business, Kevin Werbach , Dan Hunter, Wharton Digital Press, ISBN-10: 1613630239, ISBN-13: 978-1613630235
2. The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education, Pfiefer Pub.

624 - Human Computer Interaction
Course Objectives: To build human-centered design skills, so that you have the principles and methods to create excellent interfaces with any technology.

Course Contents: Introduction: Human-Computer Interaction, The Power of Prototyping, Evaluating Designs, The Birth of HCI

Needfinding:Participant Observation, Interviewing, Additional Needfinding

Rapid Prototyping: Paper Prototyping and Mockups, Video Prototyping, Creating and Comparing Alternatives

Heuristic Evaluation:Heuristic Evaluation — Why and How? Design Heuristics

Direct Manipulation and Representations: Direct Manipulation, Mental Models, Representations Matters, Distributing Cognition

Visual Design and Information Design: Visual Design, Typography, Grids and Alignment, Reading and Navigating

Designing experiments: Designing Studies That You Can Learn From, Assigning Participants To Conditions, In-Person Experiments, Running Web Experiments, Comparing Rates.

Main Reading:

1. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction (3rd Edition), Pearson, 2004.
2. Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction (5th Edition), 5th ed., Pearson Addison-Wesley, 2009
3. Donald A. Norman, The Design of Everyday Things, Basic Books, 2002

625 - Agile Software Engineering

Course Objectives: The objective of the course is to provide students with a theoretical as well as practical understanding of agile software development practices and how small teams can apply them to create high-quality software.

Course Contents: Introduction to Agile Software Development: Understanding how traditional software development works and it's problems; Role of Agile practices in the world of software development & Tools used

Agile Project Planning And Management: Requirement Analysis, Estimation techniques, Iteration planning, Introduction to development practices:TDD : Test Driven Development & Pair Programming, Introduction to QA Practices:Fail Fast & Automated functional testing, Introduction to Continuous Integration

Coding and testing practices: Practicing TDD and pair programming as alternative to traditional documentation; Configuring Continuous Integration tools; Automated function testing in detail, Source Control

Agile Software development and deployment: Iterative and incremental software development, Automated and scripted deployment strategies, Handling change requests

Main Reading:

1. Agile Software Development with Scrum, Ken Schwaber, Mike Beedle, Prentice Hall
2. Agile Estimating and Planning by Mike Cohn, Prentice Hall PTR
3. Continuous Integration: Improving Software Quality and Reducing Risk, Paul M. Duvall, Steve Matys, Andrew Glover, Addison Wesley
4. Leading Lean Software Development: Results Are not the Point Mary Poppendieck , Tom Poppendieck

631- Distributed Databases

Course Objectives: This course will introduce principles and foundations of distributed databases, including architecture, design issues, integrity control, query processing and optimization, transactions, and concurrency control.

Course Contents: Features of Distributed versus Centralized Databases, Principles Of Distributed Databases , Levels Of Distribution Transparency, Reference Architecture for Distributed Databases , Types of Data Fragmentation, Integrity Constraints in Distributed Databases.

Translation of Global Queries to Fragment Queries, Equivalence Transformations for Queries, Transforming Global Queries into Fragment Queries, Distributed Grouping and Aggregate Function Evaluation, Parametric Queries.

Optimization of Access Strategies, a Framework for Query Optimization, Join Queries, General Queries.

The Management of Distributed Transactions, A Framework for Transaction Management, Supporting Atomicity of Distributed Transactions, Concurrency Control for Distributed Transactions, Architectural Aspects of Distributed Transactions.

Concurrency Control, Foundation of Distributed Concurrency Control, Distributed Deadlocks, Concurrency Control based on Timestamps, Optimistic Methods for Distributed Concurrency Control.

Reliability, Basic Concepts, Nonblocking Commitment Protocols, Reliability and concurrency Control, Determining a Consistent View of the Network, Detection and Resolution of Inconsistency, Checkpoints and Cold Restart, Distributed Database Administration, Catalog Management in Distributed Databases, Authorization and Protection.

Architectural Issues, Alternative Client/Server Architectures, Cache Consistency Object Management, Object Identifier Management, Pointer Swizzling, Object Migration, Distributed Object Storage, Object Query Processing, Object Query Processor Architectures, Query Processing Issues, Query Execution , Transaction Management, Transaction Management in Object DBMSs , Transactions as Objects.

Database Integration, Scheme Translation, Scheme Integration, Query Processing Query Processing Layers in Distributed Multi-DBMSs, Query Optimization Issues. Transaction Management Transaction and Computation Model Multidatabase Concurrency Control, Multidatabase Recovery, Object Orientation And Interoperability Object Management Architecture CORBA and Database Interoperability Distributed Component Model COM/OLE and Database Interoperability, PUSH-Based Technologies

Main Reading:

1. Principles of Distributed Database Systems, M.Tamer Ozsu, Patrick Valduriez - Pearson Education.

Additional References:

1. Distributed Database Principles & Systems, Stefano Ceri, Giuseppe Pelagatti McGraw-Hill.

632 - Design Of Distributed Systems

Course Objectives: This course will introduce principles and foundations of distributed systems, including architecture, functional models, distributed operating systems, distributed resource management, introduction to distributed algorithms, and resource security and protection.

Course Contents: Introduction – Examples of Distributed Systems – Resource Sharing and the Web – Challenges- System Models - Introduction – Architectural Models – Functional Models- Characterization of Distributed Systems – Client-Server Communication – Distributed Objects and Remote Invocation – Communication Between Distributed Objects – Remote Procedure Call – Events and Notifications.

Distributed Operating Systems - Introduction – Issues – Communication Primitives – Inherent Limitations - Lamport's Logical Clock; Vector Clock; Causal Ordering; Global State; Cuts; Termination Detection. Distributed Mutual Exclusion – Non-Token Based Algorithms – Lamport's Algorithm - Token-Based Algorithms – Suzuki-Kasami's Broadcast Algorithm – Distributed Deadlock Detection – Issues – Centralized Deadlock-Detection Algorithms - Distributed Deadlock-Detection Algorithms. Agreement Protocols – Classification - Solutions –Applications.

Distributed Resource Management - Distributed File systems – Architecture – Mechanisms – Design Issues – Distributed Shared Memory – Architecture – Algorithm – Protocols – Design Issues. Distributed Scheduling – Issues – Components – Algorithms.

Introduction to Distributed Algorithms, Kinds of Distributed Algorithm, Timing Models. Synchronous Network Algorithms: Synchronous Network Model, Leader Election in a synchronous Ring, Algorithms in a General Synchronous Networks, Distributed Consensus with Link Failures, Distributed Consensus with Process failures, More Consensus problems.

Resource Security and Protection - Introduction – The Access Matrix Model –

Implementation of Access Matrix Model – Safety in the Access Matrix Model – Advanced Models of protection – Data Security.

Main Reading:

1. George Coulouris, Jean Dellimore and Tim KIndberg, "Distributed Systems Concepts and Design", Pearson Education, 4th Edition, 2005 [Unit-I].
2. Mukesh Singhal and N. G. Shivaratri, "Advanced Concepts in Operating Systems", McGraw-Hill, 2001 [Units II - IV].
3. Joshy Joseph and Craig Fellenstein, "Grid Computing", IBM Press, 2004. [Unit –V].
4. Ajay D. Kshemkalyani and Mukesh Singhal, " Distributed Computing – Principles, Algorithms and Systems", Cambridge University Press, 2008.
5. Pradeep K. Sinha, Distributed Operating Systems, PHI, 2005.
6. Nancy A. Lynch, Distributed Algorithms, Morgan Kaufmann Publishers, 2000.

633 - Systems Performance Evaluation

Course Objectives: The objective of this course to understand the fundamental concepts of computer system performance evaluation. This will include introduction to mathematical modelling techniques (Markov Chains, Queuing Theory and Networks of Queues), workload characterization, measurement of performance metrics, Linear Regression Models.

Course Contents: The art of performance evaluation – Professional organizations, journals, and conferences - Performance Projects – Common Mistakes in Performance Evaluation – A systematic approach to Performance Evaluation – Selection of techniques – Performance metrics - Utility classification – Setting performance requirements.

Types of workloads – Instruction mixes – Kernels – Synthetic Programs – Application Benchmarks – Art of Workload selection - services exercised – level of detail – Representativeness – Timeliness – Other considerations in Workload selection - Workload Characterization Techniques – Terminology – Averaging – Specifying Dispersion – Single Parameter and Multi parameter Histograms – Principal-Component Analysis – Markov models – Clustering.

Monitors – Terminology – Classifications – Software and Hardware Monitors – Firmware and Hybrid Monitors – Distributed-System Monitors – Program Execution Monitors – Accounting Logs – Analysis and Interpretation of log data – Capacity Planning and Benchmarking – Load Drivers – Remote-Terminal Emulation –Art of Data Representation – Guidelines for preparing good graphical charts – Gantt Charts – Kiviat Charts – Schumacher Charts.

Summarizing Measured Data – Basic Probability and Statistics Concepts – Geometric Mean – Harmonic Mean – Mean of a Ratio – Index of Dispersion – Determining Distribution of Data - Sample versus Population – Confidence Interval for the Mean – Testing for a Zero mean - Hypothesis Testing versus Confidence Intervals – Confidence Intervals for Proportions – Determining Sample Size.

Linear Regression Models – Distributions: Bernoulli, Binomial, Chi-Square, Exponential, Geometric, Normal, Pareto, Poisson, Student's t, Continuous and Discrete Uniform – Relationships among distributions – Queuing Theory – Notation – Rules – Little's Law Birth-Death Processes – M/M/1, M/M/m, M/M/m/B queues – Queuing Network Models for Computer Systems.

Main Reading:

1. R.K.Jain, "The Art of Computer Systems Performance Analysis – Techniques for Experimental Design, Measurement, Simulation, and Modeling", Wiley-India, 2008.
2. R.Pannerselvam, "Research Methodology", PHI, 2004.

634 - Cloud And Utiltiy Computing

Course Objectives: To study important approaches in the field of Cloud and Utility Computing.

Course Contents: Introduction to Cloud Computing- The Evolution of Cloud Computing – Hardware Evolution – Internet Software Evolution – Server Virtualization - Web Services Deliver from the Cloud – Communication-as-a-Service – Infrastructure-as-a-Service – Monitoring-as-aService – Platform-as-a-Service – Software-as-a-Service – Building Cloud Network.

Federation in the Cloud - Presence in the Cloud - Privacy and its Relation to Cloud-Based Information Systems – Security in the Cloud - Common Standards in the Cloud – End-User Access to the Cloud Computing.

Introduction - Advancing towards a Utility Model – Evolving IT infrastructure – Evolving Software Applications – Continuum of Utilities- Standards and Working Groups – Standards Bodies and Working Groups – Service Oriented Architecture – Business Process Execution Language – Interoperability Standards for Data Center Management - Utility Computing Technology – Virtualization – Hyper Threading – Blade Servers - Automated Provisioning - Policy Based Automation – Application Management – Evaluating Utility Management Technology - Virtual Test and development Environment - Data Center Challenges and Solutions - Automating the Data Center.

Software Utility Application Architecture - Characteristics of an SaaS - Software Utility Applications - Cost Versus Value - Software Application Services Framework - Common Enablers – Conceptual view to Reality – Business Profits - Implementing Database Systems for Multitenant Architecture.

Other Design Considerations - Design of a Web Services Metering Interface - Application Monitoring Implementation - A Design for an Update and Notification Policy -
Transforming to Software as a Service - Application Transformation Program - Business
Model Scenarios - Virtual Services for Organizations - The Future.

Main Reading:

1. John W. Rittinghouse and ames F. Ransome, “Cloud Computing Implementation, Management and Security”, CRC Press, Taylor & Francis Group, Boca Raton London New York. 2010 [Unit 1 and Unit 2].
2. Alfredo Mendoza, “Utility Computing Technologies, Standards, and Strategies”, Artech House INC, 2007 . [Unit 3 to Unit 5].
3. Guy Bunker and Darren Thomson, “Delivering Utility Computing”, John Wiley & Sons Ltd, 2006.

635 - Data Analytics

Course Objectives: To Learn about the most effective data analytics methods to solve problems and achieve insight.

Course Contents: Data: types of data, data quality, data preprocessing, measures of similarity and dissimilarity, Exploring data: Iris dataset, summary statistics, visualization.

Data Warehousing and OALP; Aggregation Operations, models for data Warehousing, star schema, fact and dimension tables Life cycle of data warehouse development, data warehouse architecture, efficient methods of data cube computation, relationship between data warehouse and data mining.

Association Analysis: Frequent itemset generation, rule generation, compact representation of frequent itemsets, FP-growth algorithm, evaluation of association patterns.

Association Analysis: advanced topics: handling categorical and continuous attributes, Handling concept hierarchy, sequential patterns, subgraph patterns, infrequent patterns.

Classification: general approach, decision tree induction, model overfitting, evaluating performance of a classifier, methods of comparing classifiers.

Classification: alternative techniques: rule based classifier, nearest neighbor classifier, Bayesian classifier, ANN, SVM, ensemble methods.

Cluster Analysis: K-means, agglomerative hierarchical clustering, DBSCAN, cluster evaluation, density based clustering, BIRCH, CURE.

Anomaly detection: statistical approaches, proxy-based outlier detection, density-based outlier detection, cluster based techniques.

Main Reading:

1. Peng-Ning Tan,Michael Steinbach and Vipin Kumar, Introduction to Data Mining, Pearson Education.
2. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques," 1st Edition Indian Reprint 2001, Harcourt India Private Limited, ISBN 1-55860-489-8.
3. Arun K Pujari, "Data Mining Techniques". Universities Press.

636 - Information Retrieval

Course Objectives: Basic and advanced techniques for text-based information systems: efficient text indexing; Boolean and vector based retrieval models; Web search including crawling.

Course Contents: Overview of Information Retrieval: Function of an IR system, Kinds of IR systems, Components of an IR system, Problems in designing an IR system.The nature of unstructured and semi-structured text.

Text Analysis and Indexing: Preliminary stages of text analysis and document processing, tokenization, stemming, lemmatization, stop words, phrases, Indexing: Boolean IR models, inverted files, indexing, signature files, PAT trees, Positional indices. Vector-based IR models: TF/IDF term weighing, similarity measures, test collections and issues.

Index construction and Compression: Postings size estimation, merge sort, dynamic indexing, positional indexes, n-gram indexes. Index compression: lexicon compression and postings lists compression. Gap encoding, gamma codes, Zipf's Law. Blocking. Extreme compression.

Query Processing: Query expansion: spelling correction and synonyms. Wild-card queries, permuterm indices, n-gram indices. Edit distance, soundex, language detection.

Matching techniques: Similarity between documents and queries, Parametric or fielded search. Document zones. The vector space retrieval model, tf.idf weighting. Scoring documents, vector space scoring, the cosine measure, efficiency considerations, reduced dimensionality approximations, Latent Semantic Indexing (LSI), random projection, Page Ranking and HITS.

Information Extraction: Information extraction, Named entity extraction, Question Answering. Summarization - Qualities of good summary, summary types, extract summary.

Evaluation of IR systems: Assessment of the performance of IR systems - Precision, Recall, F-Measure. Criteria for evaluation, measuring 'goodness', tests of IR systems. Presentation of search results, display of search results, manipulation of search results.

Relevance feedback: User modeling and information need: user profiling, Relevance judgments. Additional term selections to the system, Dynamic respond ally to judgments and selections, Personalization of search.

Taxonomy and Ontology: Creating domain specific ontology, Ontology life cycle.

Distributed and Parallel IR: Relationships between documents, Identify appropriate networked collections, Multiple distributed collections simultaneously.

Web Search Engines: Web crawlers, robot exclusion, Web data mining, Metacrawler, Collaborative filtering, Web agents (web shopping, bargain finder,..), Economic, ethical, legal and political issues.

Multimedia IR: Techniques to represent audio and visual document, Query databases of multimedia documents, Display the results of multimedia searches.

Main Reading:

1. Managing Gigabytes, by I. Witten, A. Moffat, and T. Bell.
2. Modern Information Retrieval, by R. Baeza-Yates and B. Ribeiro-Neto.
3. Information Retrieval: Algorithms and Heuristics by D. Grossman and O. Frieder

APPENDIX B

FORM-I

(To be submitted on the letter head of the Organization)

Format of Certificate by the Employer/Management for Sponsored Candidates

This is to certify that Shri./Smt._____
is working in this Organization as _____ since _____and he/she is permitted to study for M.Tech program at Goa University. If he/she is admitted to the said program, he/she will be permitted to attend the Classes as a full-time/part-time candidate during the working hours till completion of his/her program. We understand that he/she will fulfill University norms for the attendance.

This is to further certify that he/she has been appointed on regular basis in this Organization and his/her appointment is not temporary.

Head of the Sponsoring Organization

Date, Signature & Stamp

APPENDIX C
Syllabus for Computer Science and Information Technology (CS)

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non-linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

Digital Logic: Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point).

Computer Organization and Architecture: Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage.

Programming and Data Structures: Programming in C; Functions, Recursion, Parameter passing, Scope, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps.

Algorithms: Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and-conquer; Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes – P, NP, NP-hard, NP-complete.

Theory of Computation: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability.

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.

Operating System: Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

Databases: ER-model, Relational model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B+ trees), Transactions and concurrency control.

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Computer Networks: ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), Application layer protocols (icmp, dns, smtp, pop, ftp, http); Basic concepts of hubs, switches, gateways, and routers. Network security – basic concepts of public key and private key cryptography, digital signature, firewalls.

Web technologies: HTML, XML, basic concepts of client-server computing.