

**UNIVERSITY OF DELHI**  
**MASTER OF SCIENCE IN INFORMATICS**  
**(M.Sc. Informatics)**  
(Effective from Academic Year 2019-20)

**PROGRAMME BROCHURE**



**Institute of Informatics & Communication (IIC)**  
**University of Delhi South Campus**  
**New Delhi – 110021**

**As approved in the faculty meeting on 3<sup>rd</sup> July 2019**

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## **I. About IIC**

Information Technology integrates a wide spectrum of knowledge and skill ranging from the design of computer hardware, software systems, and telecommunication to the impact of information technology on society. To achieve this holistic goal the Institute of Informatics & Communication (IIC) was established in 1997 with the following objectives:

- To serve as an inter-disciplinary centre for humanities, social sciences, pure and applied sciences and as a nodal point between university and various Institutions/Industries, related to communication and informatics.
- To conduct professional / socially relevant post-graduate teaching programmes, independently or in collaboration with various departments on different aspects on communication and informatics.
- To conduct research on various aspects of informatics and communication.

The Institute of Informatics and Communication of the University of Delhi South Campus is a unique institution from several points of view. For one, it offers a two-year M.Sc. (Informatics) that combines high-end knowledge with useful real world applications in several areas of information technology and communications. For another, it trains the student to think analytically and imparts a degree of maturity and independence to the student through some innovative schemes. The Institute also trains its students to imbibe the ability to stay abreast with recent developments in the various areas that are related to Informatics so that they are able to perform at optimum levels in their subsequent professional careers. The curriculum at Institute of Informatics and Communication (IIC) attempts to prepare its graduates for meaningful and challenging jobs in IT Industry. The learning environment in the Institute encourages initiative, teamwork and development of entrepreneurial skills.

The learning approach at IIC includes classroom lectures, tutorials, project assignment and Internet access. The students are encouraged to develop their skills and acquire theoretical knowledge and practical training in electronics, telecommunication and computer hardware and software. To improve the communication skills of students and to increase their confidence, students are required to make presentations with the help of visual aids during the fortnightly seminar sessions.

The selection process to enter the Postgraduate programme is rigorous and the number of seats is restricted to ensure quality education. The Institute provides an excellent environment for learning and innovation. IIC aims towards the development of intense research activity in various areas of Informatics and Telecommunications, and towards participating in national and international competitive research and development projects to attract external resources. The research staff of the IIC Department is thriving for quality work have published papers in leading scientific journals, have developed important national cooperations with related departments abroad, and participate in scientific committees of prestigious international and conferences.

## II. Introduction to CBCS (Choice Based Credit System)

### Choice Based Credit System

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

#### Definitions:

- (i) 'Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre
- (ii) 'Course' means a segment of a subject that is part of an Academic Programme
- (iii) 'Programme Structure' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission
- (iv) 'Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course
- (v) 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre
- (vi) 'Open Elective' means an elective course which is available for students of all programmes, including students of same department. Students of other Department will opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.
- (vii) 'Credit' means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course
- (viii) 'SGPA' means Semester Grade Point Average calculated for individual semester.
- (ix) 'CGPA' is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.
- (x) 'Grand CGPA' is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into %age marks is given in the Transcript.

**Revised Structure: Master of Science in Informatics (M.Sc. - Informatics)**

Code	Title of Course	Credits
<b>First Semester</b>		
<i>Foundation Course (2 weeks)</i>	<i>Fundamentals of Computing, Introduction to Programming, Internet &amp; Web Technologies, Design Informatics</i>	0
ITCC101	Software Design & Programming	6
ITCC102	Algorithms and Data Structure	6
ITCC103	Computer System Architecture	6
ITCC104	Mathematical Foundation of Computing	6
<b>Second Semester</b>		
Code		Credits
ITCC201	Computer Communication and Networks	6
ITCC202	Database Systems	6
ITCC203	Operating Systems	4
ITCC204	Applied Machine Learning	4
ITOE205	Open Elective –I	4
<b>Third Semester</b>		
Code		Credits
ITCC301	Software Engineering	6
ITCC302	Information System Design	6
ITCC303	IT Planning & Management	6
ITEC304	Elective – I (with Lab)	6
<b>Fourth Semester</b>		
Code		Credits
ITCC401	Research Methods in Informatics	4
ITCC402	Internet of Things Systems, Security and Cloud	4
ITCC403	Project	12
ITEC404	Elective-II	4
<b>Elective &amp; Open Elective Courses</b>		
Code		Credits
ITEC01	Embedded System Design	4
ITEC02	Data Analytics and Visualisation	4
ITEC03	Cloud Computing	4
ITEC04	Health Informatics	4
ITOC01	IT Policy framework and Standards	4
ITOC02	Web & Mobile Application Development Frameworks	4
ITOC03	Cyber Security & Forensics	4

**Note:** For each paper theory and practical have to be cleared separately.

## Program Layout

Sem.	Core Courses			Elective Course			Open Elective Course			Total Credits
	No. of papers	Credits (L+P)	Total Credits	No. of papers	Credits	Total Credits	No. of papers	Credits	Total Credits	
I	4L + 4P	16L + 8P	24	0	0	0	0	0	0	24
II	4L + 3P	16L + 4P	20	0	0	0	1L	4L	4	24
III	3L + 4P	12L + 8P	20	1L	4L	4				24
IV	(2L + 1 PROJE T)	8L + 12 PROJE T	20	1L	4L	4	0	0	0	24
<b>Total Credits for the Course</b>			<b>84</b>			<b>8</b>			<b>4</b>	<b>96</b>

### Selection of Elective Courses:

The selection of Electives and Open Electives will be based on the mutual understanding of the students and the faculty concerned. However, choice will be given to the students to choose an elective out of the given option.

### Teaching:

The faculty of the Department is primarily responsible for organizing lecture work for the courses defined in the syllabus. The instructions related to tutorials are provided by the respective registering units under the overall guidance of the Department. As required, Faculty from Industry and other Departments and constituent colleges will also be associated with lecture/practical work in the Department. There shall be 90 instructional days excluding examination in a semester.

### Evaluation of project report

The project convener will assign student/group of students to a teacher/responsible person from industry/organisation for their project. At the end of Project period, students will be required to submit a written Project report to the convener.

The Project report will be examined by the board of examiners (one board for 10 or less candidates). The board will consist of:

- Project Convener
- One expert to be appointed by the Director, South Campus/ Dean of the Faculty of Interdisciplinary Applied Science on the recommendation of the Chairman, ERC (Evaluation and Review Committee).
- Project Supervisor

The grade of the student will be decided on the basis of written report and viva.

If a candidate gets 'F' grade in the project, the ERC on the request from the student may consider the Project Report in lieu of industrial training report to award a grade and recommend to the University for the award of M.Sc. (Informatics) degree.

### **Evaluation of Dissertation**

A candidate may request for a dissertation in place of the courses of VI semester by giving a proposal or a plan of work to the Programme Co-ordinator within a week of submission of V semester Project. The proposal will be examined by the ERC if necessary by taking opinion of external expert. On the approval of the ERC he/she can be given dissertation in lieu of the courses of VI semester, and the ERC will appoint a supervisor for dissertation.

The dissertation should normally be submitted within the span period of VI semester. However, ERC may grant extension, not exceeding the maximum duration of the programme but not more than six months at a time. The dissertation will be examined by the supervisor and two experts appointed by the Vice-chancellor on the recommendation of the ERC. If the examiners approve the dissertation, a viva-voce examination will be held and grade point is awarded taking into consideration both dissertation and viva. In case the student gets 'F' grade, he/she will be recommended for the award of M.Sc. (Informatics) degree as he/she would have already acquired the required credit.

### **Eligibility For Admission**

A candidate must have passed B.Sc. (H) Physics or B.Sc. (H) Electronics or B.Sc.(H) Chemistry or B.Sc. (H) Mathematics/Statistics with Physics as subsidiary, B.Sc. (three Subject Scheme), Physics, (Mathematics and one of Chemistry, Electronics, Computer Sciences etc.) B Appl. Sc. (Electronics/Instrumentation) from University of Delhi or equivalent qualification from a recognised University /Institution with at least 50% marks.

OR

A candidate must have passed B.E./B.Tech. degree in Electronics and Communication / Computer / Electrical and Electronics / Instrumentation from the University of Delhi or equivalent qualifications from recognised University/Institutions with at least 50% marks.

### **Procedure for Admission**

The admission will be made on the basis of an all india entrance Test followed by interview and group discussions.

There will be two sections of the papers:

Part I - General English comprehension, Analytical ability and Reasoning.

Part II - Mathematics, Physics, Electronics and Computer Science up to the level of B.Sc. (H) Physics/B.Sc. (H) electronics.

85% weightage will be for written test and 15% for interview and group discussion (the interview pattern will be on the same lines as for other professional courses like MCA/MBA). The detailed syllabus for admission test, weightage and duration for different test papers will be framed by the Admission Committee.

### Grading system and classification of result:

The grade awarded to a student in any particular course will be based on his/her performance in end semester examination. The letter grades that can be awarded and their equivalent grade points are listed below:

Grade	Grade points	Percentage	Description of performance
A	10	(91-100)	Outstanding
A-	9	(81-90)	Excellent
B	8	(71-80)	Very good
B-	7	(60-70)	Good
C	6	(50-60)	Average
D	4	(40-50)	Below Average
P	0	<40	Poor
I	-	-	Incomplete

For the purpose of calculation of GPA for GPA (semester) or CGPA, only those courses will be taken into account in which the student has been awarded one of A to D grades.

### SGPA and Grand SGPA:

The Grade Point Average (GPA) is calculated as follows:

$$\text{GPA} = \frac{\sum \text{Number of Credits} \times \text{Point Grade}}{\sum \text{Number of Credits}}$$

### F GRADE

This grade refers to unsatisfactory performance in a course. A student is required to repeat all theory and practical courses in which he/she obtains a F Grade.



### **Guidelines for the Award of I Grade**

'I' grade may be awarded to a student if he/she has not fulfilled all the requirements for the course on account of extraordinary circumstances subject to having at least 50% attendance in laboratory classes. The concerned course Co-ordinator should be convinced about the extraordinary circumstances and should certify the attendance record before this rarely used option to award 'I' grade is recommended.

The 'I' grade shall be converted into a proper grade within 10 days from the date on which all the major tests (end semester exam.) are over.

A student will be allowed to be promoted to next semester only if (i) he/she secured at least 'D' grade in all practical. No practical will be allowed to be carried over and (ii) Secured at least 'D' grade in two theory papers (for four theory semester) or in three theory papers (for five theory semester)

The student, who has to repeat the theory course of any semester, will have to pay additional registration fee for that semester(s) in addition to fee for the semester in which he/she is studying. He/she has to appear in the course of reading, which is prescribed for the fresh students, and the examination will be held along with the regular students of the semester.

### **Attendance Requirement:**

Attendance in all classes is compulsory. If the attendance of any student is considered to be unsatisfactory (below 75% in any subject, he would not be permitted to appear in the examination of that particular subject. A student with poor attendance record (less than 75%) may be asked to repeat, the subject. However, condonation upto 25% on medical ground may be given.

### **Assessment of Students' Performance and Scheme of Examinations:**

Each course will carry 10 grade points. The mode of evaluation shall be as follows:  
for each theory course

<b>Internal Assessment</b>	<b>25%</b>
<b>End Semester</b>	<b>75%</b>

For a practical course 40% weightage will be given for evaluation during the semester and 60% at the end of semester examination/viva-vice.

The duration of end semester theory and practical examination shall be three hours.

### **Maximum Duration**

If a student has not performed satisfactorily in the courses or he has not been able to attend on account of unavoidable reasons (sickness etc.) and he wishes to continue his studies, he would be suitably advised to moderate his study plan during the subsequent semester (s). Accordingly such a student would take a longer period to complete the total requirement and as such,

provision has been made to accommodate such cases. Accordingly, the maximum durations allowed to complete the overall requirements in respect of Postgraduate programmes are tabulated below:

<b>Programme</b>	<b>Min. No. of credits</b>	<b>Normal Duration</b>	<b>Max. Duration</b>
M.Sc. (Informatics)	96	4 Semester	4 Years

### **Degree Requirements**

A degree will be awarded to a student who meets the following academic requirements:

- A. Successful completion of assessments in 14 core courses (CC).
- B. Successful completion of assessment in 2 elective courses (EC) and one open elective course (OC).
- C. Successful completion of the Project Dissertation.
- D. When the student has successfully completed the assessment of courses of a total of 96 credits

The degree grade has the following classification:

<b>Grade</b>	<b>Grade points</b>	<b>Percentage</b>	<b>Description of performance</b>
<b>A</b>	10	(91-100)	Outstanding
<b>A-</b>	9	(81-90)	Excellent
<b>B</b>	8	(71-80)	Very good
<b>B-</b>	7	(60-70)	Good
<b>C</b>	6	(50-60)	Average
<b>D</b>	4	(40-50)	Below Average
<b>P</b>	0	<40	Poor
<b>I</b>	-	-	Incomplete

### III. M. Sc. (Informatics) Programme Details

#### Programme Objectives (POs)

The Institute of Informatics and Communication offers a modern and competitive study programme, that incorporates the international developments of the respective fields. The curriculum aims to provide students with basic knowledge and skills on informatics and telecommunications, as well as with specialised knowledge so that they acquire a sound scientific background and be able to fully cope with the increasing demands of the associated industry.

The structure of the curriculum follows the guidelines of the main international scientific and professional associations on Informatics and Telecommunications, i.e. those of ACM and IEEE. It has incorporated the accumulated experience of the faculty, as well as the findings of the External Evaluation Report.

The aims of the programme, in more detail, are the following:

- To inspire the students on the subjects they have chosen to study and to create an interesting and fruitful learning experience for them.
- To develop- knowledge, understanding and abilities in informatics and telecommunications and related technologies.
- To provide the students with the knowledge and abilities necessary for them to evolve into competent professionals.
- To provide the students the opportunity to get in touch with the most recent and innovative scientific and technological advances in informatics and telecommunications.
- To provide education and learning through a multitude of educational activities, in order to develop abilities that will be applicable to the professional career.
- To prepare the students for further work and research in informatics and telecommunications.
- To provide the students with the knowledge and abilities necessary for them to be able to form scientifically sound solutions to problems pertaining to informatics and telecommunications.

#### Programme Learning Outcomes (PLOs):

Students of Institute of Informatics and Communication that have successfully graduated will Have acquired the necessary knowledge on working principles on the fields of information and telecommunication systems, networks, services and applications.

The plausible outcomes can be broadly classified as:

#### Knowledge and understanding

- Know the fundamental issues of the disciplinary fields of Informatics and Telecommunications and will be able to propose scientifically grounded and innovative solutions in the field of ICT applications, as well as to estimate the cost-benefit ratio of each solution.
- Understand the principles of economical and managerial aspects of running projects related to Informatics and Telecommunications.
- Understand issues related to social, legal, educational and ethical aspects of Informatics and Telecommunications.

### **Application of knowledge and understanding**

- Be capable of applying their knowledge and understanding so as to become effective professionals
- Possess appropriate skills to develop sector-specific solutions.
- Have the ability to apply the theories of informatics and telecommunications in modern information & telecommunication systems, as well as in related research areas.
- Have the potential to recognize the tools and techniques suitable for the problems at hand and apply them effectively, so as to successfully complete complex projects.
- Be able to conduct experiments that involve tests and measurements, as well as analyze, interpret and present the produced results.
- Have the ability to undertake and successfully execute projects both as individuals and as members of a technical team.
- Be capable of working effectively in a team in order to manage, design, test certify the performance of ICT systems.

### **Critical Problem Solving**

- Will be capable of recognizing, formulating and solving problems in the design, management and evolution of informatics and communication systems.
- Have the potential to carry out experimental testing and assess the performance of ICT hardware/software, as well as evaluate the extent to which an implemented system conforms to its specifications.
- Understand scientific and technical publications and be able to formulate their personal opinion on their importance and implications.
- Demonstrate insight into the potential limitations of technology, the role it plays in the society and the personal responsibility on its use, including social, economic, environmental and work aspects.
- Be able to determine their needs to acquire new knowledge and continuously extend their knowledge and skills.

### **Communication**

- Be proficient in communicating problems, ideas, solutions, technical information effectively and efficiently;
- Have the capability produce technical reports on the activities carried out and present summaries of the key results in group discussions;

### **Life Long Learning**

- Be able to recognize and adapt to new methods, techniques and instruments used in all phases of ICT systems' and applications' lifecycle.
- Have the capacity to follow scientific and technological developments in the ICT domain and determine needs for further knowledge acquisition and skill development
- Have the potential to continue further studies in all fields of informatics and communications.

### **Programme Specific Outcomes (PSOs):**

Foundation program is to orient students with diverse background, so that all the students are aligned with the objective of the programs. Following topics are covered in this two weeks' foundation program, which is the integral part of the 1st Semester:

- Fundamental of Computing,
- Introduction to Programming,
- Internet & Web Technologies
- Design Informatics

To make all the students aware of computer terminology, fundamental concepts used in software, computer hardware and its operation, operating systems and application software, networks and computer communications, the Internet and the World Wide Web, and programming, fundamental of Programming, Foundations of Computer Network, Internet basics, study of appropriate methods and design processes using Informatics.

## **First Semester - Programme Specific Outcomes**

### **IT11 Software Design & Programming**

Programming Methodology and Concepts are studied with reference to efficient software design and development. Concept of programming and structured program development, Problem specifications: Top down design, Step-wise refinement, Sub programs, Recursion algorithms, Analysis of algorithms. Data structure and data types, Program debugging and testing, Performance evaluation, Correctness of programs, Programming exercises as a part of laboratory.

### **IT12 Algorithms and Data Structure**

Review of abstract data types and simple data structures. Linked list, Circular linked list, Array Stack, Queue, Trees, Hyper Graph, Forest and File. Introduction to Algorithms: Asymptotic notations, Summation, Recurrence relations. Divide and Conquer Binary Search, Quick sort, Merge sort. Dynamic Programming: Matrix chains Multiplication, trees, Knapsack problems, shortest path Algorithms. Graph Depth first search, Breadth first search, Topological sort and strongly connected components. Theory: Lower bounds for sorting and selection.

### **IT13 Computer System Architecture**

Evolution of computer architecture and the factors influencing the design of hardware and software elements of computer systems. Instruction set design; processor micro-architecture and pipelining; cache and virtual memory organizations; protection and sharing; I/O and interrupts; in-order and out-of-order superscalar architectures; VLIW machines; vector supercomputers; multithreaded architectures; symmetric multiprocessors; and parallel computers.

### **IT14 Mathematical Foundation of Computing**

Discrete Mathematics Set, Relations, Functions, Operations, Well Ordering and Equivalence relation, Partial Order. Lattice and Combinatorics, Boolean Algebra, Normal forms, Trees, Graphs, Matrix representations and Enumeration of Graphs, probability, Time series Analysis, Stochastic Process, Mathematical Logic and Methods of Computation (Finite State Machines, Push down Automata, Turing m/c), Regular Set, finite Automata, Introduction to Recurring functions.

## **Second Semester- Programme Specific Outcomes**

### **IT21 Computer Communication and Networks**

Review of Data Communication principles. Study of Network topology design, Network layer switching, Routing, Congestion and flow control, Internetworking, Intranet, VPN. Evolution of Internet, Address and Domain Management, Security issues, CGI and other Internet development tools.

### **IT22 Database Systems**

Introduction to database concepts, Data organization and management techniques. Goals of DBMS including data independence consistency, Data security and Integrity. DBMS models: Hierarchical, Network and Relational, Relational algebra, Relational calculus, Query languages. Relational database design, Functional and Multi valued dependencies & normal forms. Database query optimization, Data abstraction and Modelling, ER Model, Relational Model,

Hierarchical Model, Normalization, Query Processing, Crash Recovery, Concurrency Control, Distributed database, Object Oriented database, Data Mining, Multimedia Database, Digital Libraries.

### **IT23 Operating Systems**

Study of UNIX, WINDOWS, DOS operating system concepts. Programming in UNIX, Programming in WINDOWS, Programming in DOS based languages, UNIX system tools, Programming language interface, File and Shared Libraries, Inter process communication, Common object file format, Make source code control system, Programmers productivity tools, Extended terminal interface, D Security, X Windows.

### **IT24 Applied Machine Learning**

Machine learning is a rapidly growing field at the convergence of Information technology and statistics that is concerned with finding patterns in data. It is responsible for tremendous advances in technology, from personalized product recommendations to speech recognition in cell phones. The goal of this course is to provide a broad introduction to the key ideas in machine learning. The emphasis will be on intuition and practical examples rather than theoretical results, though some experience with probability, statistics, and linear algebra will be important. Through a variety of lecture examples and programming projects, students will learn how to apply powerful machine learning techniques to new problems, run evaluations and interpret results, and think about scaling up from thousands of data points to billions.

### **IT5 Open Elective – I**

This course provides flexibility for the students to study beyond curriculum and pick any course from other Departments based on the students' choice and interests.

## **Third Semester- Programme Specific Outcomes**

### **IT31 Software Engineering**

To give an idea of software life cycle, Requirement Definition, System Modeling, Requirement Specifications, Formal Specifications, Algebraic Specifications, and Model based Specifications. Software Design, SSAD, Object Oriented Design, Function Oriented Design, Real time system Design, U.I. Design, Reliability, Re-usage.

### **IT32 Information System Design**

Follow the Design Thinking Process to create an information systems design, Create an Information Model based on design patterns including Objects/Events, Par and Inheritance. Evaluate the user experience of an existing information system based on a predefined but open-ended rubric. Demonstrate and document an information system design by creating a, forms based prototype for to support business processes, 3D graphical prototype.

### **IT33 IT Planning & Management**

Fundamental aspects of daily IT operations, human factors in organization, acquisition and procurement, research and Development, Logical planning, Relations with carriers and manufacturers. Strategic planning in regulated and competitive IT and Telecommunication

industries, the management and marketing of a technology based enterprise, the strengths and weaknesses of different Management and Marketing approaches, their legal constraints, responsibilities and ethics. The principles and methods of asset valuation, Interpretation and measurement, Financial statements risk assessment, Capital market, Capital budgeting and the effects of economic regulation on capital formation. Telecommunication and networking as applied to enterprises in public and commercial sector. IT and Telecommunication Policy and Regulation

#### **IT34 Elective – I (Any one from the detailed program description)**

This course focuses on teaching specialized courses covering the advances in specialized fields of Informatics & Communication including various technology frameworks used in research. One course may be selected from the list provided.

### **Fourth Semester- Programme Specific Outcomes**

#### **IT41 Research Methods in Informatics**

This course provides importance of informatics in research, understanding of different scientific methods and compare different research method, Analyze the literature and summarize the state of the art, Design a scientific study, choose a methodology, and create a model.

#### **IT42 Internet of Things Systems, Security and Cloud**

This course provides the conceptual understanding IoT systems architecture, hardware platforms, relevant wireless technologies and networking protocols, application of IoT in various sectors e.g. health care, agriculture, defence, security and privacy concepts, device programming and debugging, cloud integration, simple data analytics, and commercialisation challenges.

#### **IT43 Project**

In this particular course, students will be trained to work in team to develop team spirit. This is one of the most important course of the program, as the students are expected to develop a prototype based on the project taken. They will also learn the art of documentation.

#### **IT44 Elective – II (Any one from the detailed program description)**

This course focuses on teaching specialized courses covering the advances in specialized fields of Informatics & Communication including various technology frameworks used in research. One course may be selected from the list provided.



**Each Programme in all the four semesters is natively linked with dedicated hands-on Laboratory based Experiments**

**Educational Procedure**

Through the educational procedure applied at IIC, students learn to analyse scientific problems and find solutions to them, work individually and in groups, and effectively coordinate working groups. Lectures, laboratory activities and projects are basic elements of the educational procedure.

In-class and laboratory activities are an extremely important part of the unique educational experience of the student. Through these activities students and tutors share their knowledge and experience and advance their educational level both individually and collectively. Concerning the importance of these activities, students must systematically attend the lectures and the laboratory activities, be at the classroom before the beginning of the lecture, attend the lecture to the very end, and engage in the educational procedure.

The Institute of Informatics and Communication uses modern e-learning tools, such as online lecture notes, online project submission tools, announcement lists, additional educational material, etc. However, these tools cannot substitute under any circumstances the lectures and the laboratory exercises or any other activity that requires the student's physical presence, including the procedure of the exams (e.g., the assessment of the laboratory exercises). Students are expected to participate in the activities of the courses according to the course timetable and the teachers' directions.

**Programme Structure:**

The M.Sc. Programme is a two-year course divided into four-semester. A student is required to complete 96 credits for the completion of course and the award of degree.

<b>Part</b>	<b>Year</b>	<b>Semester</b>	
<b>Part - I</b>	First Year	Semester I	Semester II
<b>Part - II</b>	Second Year	Semester III	Semester IV

**Course Credit Scheme**

- Total credits of the course = 96
- Number of core papers = 13
- Project (Dissertation) = 01
- Number of elective papers = 02
- Number of Open elective paper = 01

Sem.	Core Courses			Elective Course			Open Elective Course			Total Credits
	No. of papers	Credits (L+P)	Total Credits	No. of papers	Credits	Total Credits	No. of papers	Credits	Total Credits	Grand Total
<b>I</b>	4L + 4P	16L + 8P	<b>24</b>	0	0	<b>0</b>	0	0	<b>0</b>	<b>24</b>
<b>II</b>	4L + 3P	16L + 4P	<b>22</b>	0	0	<b>0</b>	1L	4	<b>4</b>	<b>24</b>
<b>III</b>	3L + 4P	12L + 8P	<b>20</b>	1L	4L	<b>4</b>				<b>24</b>
<b>IV</b>	(2L + 1 PROJEC T)	8L + 12 PROJEC T	<b>20</b>	1L	4L	<b>4</b>	0	0	<b>0</b>	<b>24</b>
<b>Total Credits for the Course</b>			<b>84</b>			<b>8</b>			<b>4</b>	<b>96</b>

L= Lecture, P = Practical

\*For each Core and Elective Course there will be 4 lecture hours of teaching per week.

\* Open Electives to the maximum total of 8 credits.

## IV. Course Wise Content Details for M.Sc. Informatics Programme

### Masters of Science in Informatics – M.Sc. (Informatics) Semester I- Foundation Program (Two Weeks – Non Credit)

**Duration: 2 weeks**

As the students are coming from diverse background and streams, the objective is to bring all the students on the same platform so that the students are aware of computer terminology, fundamental concepts used in software, computer hardware and its operation, operating systems and application software, networks and computer communications, the Internet and the World Wide Web, and programming, fundamental of Programming, Foundations of Computer Network, Internet basics, study of appropriate methods and design processes using Informatics.

### Masters of Science in Informatics – M.Sc. (Informatics) Semester – I ITCC11: Software Design & Programming

**Marks: 100**

**Duration: 60 Hrs**

#### **Course Objectives:**

The course aims at providing necessary skills for developing software utilising the object-oriented and functional programming paradigms. Step-wise refinement, Sub programs, Recursion algorithms, Analysis of algorithms. Data structure and data types, Program debugging and testing, Performance evaluation, Correctness of programs. Programming exercises as a part of laboratory.

#### **Course Learning Outcomes:**

CO1: Efficient means of storing and retrieving data

CO2: How to identify the data structure that best represents the problem at hand

CO3: Assess and improve the quality of software design with respect to object-oriented principles.

CO4: Evaluate and evolve object-oriented software designs, making use of common design patterns if appropriate.

CO5: Discuss the use of modelling and model-driven development tools in software development, e.g. why and how models of software can have varying degrees of formality, capabilities and limitations of the tools.

**Contents:**

The object model and how it is realised in various object-oriented languages, inheritance, polymorphism, and abstraction, Language features: inner classes, closures, higher-order functions, meta-objects, etc. The functional paradigm, abstract data types, polymorphic types, static typing and type inference. Recursion and induction. List processing. Higher-order functions. Eager and lazy evaluation. Imperative features. Signatures, structures, functors, typeclasses, monads. Test Driven Design and Behavioural Driven Design, Integrated Development Environment (IDE). Modularity, versioning, packaging, and managing the build process Design Patterns and Anti-Patterns and their application to software design

**UNIT I**

Introduction to Programming Methodology, Variables and Expressions, Types, Operators and Expressions, Control Flow, Functions and Program Structure, Solving common programming problems

**UNIT II**

Pointers and Arrays, Pointer Conversion, I/O, Structures, Structure and Union Declarations, File Descriptors, UNIX System Interface, Enumerators, Declarators, Typedef, Identifiers, Preprocessing

**UNIT III**

The object model and how it is realised in various object-oriented languages, inheritance, polymorphism, and abstraction, Language features: inner classes, closures, higher-order functions, meta-objects, etc. The functional paradigm, abstract data types, polymorphic types, static typing and type inference.

**UNIT IV**

Abstraction, Refinement, Modularity, Software Architecture, Control Hierarchy, Structural Partitioning, Data Structure, Software Procedure, Information Hiding, Functional Independence, Cohesion, Coupling, Design Documentation, Principles and methods for software design with a special focus on object-oriented analysis and design, including topics such as domain modeling, software architecture, class and object modelling. Using UML, Class Diagram, Sequence Diagram, Package Diagram, and Deployment Diagram.

**UNIT V**

Software Architectural Styles and Design Patterns: Peter Coad's Collaboration Patterns, Software Architecture Styles (Model-View-Controller Style, Layered Design), Design Patterns (Factory Method, Observer, Strategy, State, Decorator, Singleton).

### Recommended Reading:

1. “Fundamentals of Software Engineering” by Rajib Mall, Prentice Hall India Learning Private Limited; Fourth edition (2014), Language: English, ISBN-10: 8120348982, ISBN-13: 978-8120348981.
2. “Software Engineering: A practitioner’s approach” by Roger S Pressman, ISBN: 9789339212087, 9339212088, Edition: 7th Edition, 2014.
3. “Software Engineering” by Ian Sommerville, Prentice Hall; Auflage: 9th revised edition. International Version (19. Februar 2010), Sprache: English, ISBN-10: 0137053460, ISBN-13: 978-0137053469.
4. “Software Engineering” by Gaurav Gupta and Deepika Gupta, ISBN-10: 3843310130 ISBN-13: 978-3843310130.
5. “Encyclopedia of Software Engineering” by LaPlante LaPlante, ISBN: 9781420059779, 1420059777, Edition: 2010
6. “Software Engineering 1st Edition” by Udit Agarwal, Publisher: SK Kataria & Sons ISBN: 9789350142363, 9350142368, Edition: 1st, 2012, Pages: 375.

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – I**  
**ITCC12: Algorithms and Data Structure**

**Marks: 100**

**Duration: 60 Hrs**

### Course Objectives:

The course covers basic algorithmic techniques and ideas for computational problems arising frequently in practical applications: sorting and searching, divide and conquer, greedy algorithms, dynamic programming. It provides enough theory to how to sort data and how it helps for searching; how to break a large problem into pieces and solve them recursively; when it makes sense to proceed greedily; how dynamic programming is used in genomic studies. You will practice solving computational problems, designing new algorithms, and implementing solutions efficiently

### Course Learning Outcomes:

CO1: Describe the basic data structures and the operations that they support.

CO2: Describe the algorithms that allow the execution of the above operations and the computational resources that they require.

CO3: Implement data structures in C.

CO4: Select the appropriate data structures depending on the computational problem.

CO5: Describe algorithms for a series of classical computational problems and show their execution on typical instances.

CO6: Apply algorithm design techniques and construct efficient algorithms.

CO7: Describe algorithms with clarity in words and in pseudocode. Analyze the complexity of an algorithm and prove its correctness. recognize basic notions of NP-completeness theory.

**Contents:**

Lists. Tables. Queues. Trees. Tree traversals. Priority queues. Binary search trees. AVL trees. Hashing. Sorting. Graphs. Algorithms and computational problems, Analysis of algorithms, Asymptotic notations, Recurrence relations. Design techniques: Divide-and-Conquer, Greedy algorithms, Dynamic programming. Graph algorithms: Breadth first search, Depth first search, Topological sorting, Minimum spanning trees, Shortest paths. Introduction to complexity theory: P, NP, and NP-complete problems, Polynomial-time reductions. Special topics: Approximation algorithms, Randomized algorithms and Computational geometry.

**UNIT I**

Algorithms and computational problems, Analysis of algorithms, Asymptotic notations, Recurrence relations.

**UNIT II**

Linked Lists. Tables. Queues. Trees. Tree traversals. Priority queues. Binary search trees. AVL trees. Hashing. Theory: Lower bounds for sorting and selection. Graphs.

**UNIT III**

Design techniques: Divide and Conquer with examples such as Sorting, Matrix Multiplication, Convex hull and Searching. Greedy methods with examples such as Optimal Reliability Allocation, Knapsack, Minimum Spanning trees – Prim’s and Kruskal’s algorithms, Single source shortest paths - Dijkstra’s and Bellman Ford algorithms.

**UNIT IV**

Dynamic programming. All pair shortest paths – Warshal’s and Floyd’s algorithms, Resource allocation problem. Backtracking, Branch and Bound with examples such as Travelling Salesman Problem, Graph Coloring, n-Queen Problem, Hamiltonian Cycles and Sum of subsets.

**UNIT V**

Introduction to complexity theory: P, NP, and NP-complete problems, Polynomial-time reductions. Special topics: Approximation algorithms, Randomized algorithms and Computational geometry.

**Recommended Reading:**

1. “Data Structures using C and C++” by Y Langsam, Pearson Education India; 2 edition (2015), ISBN-10: 9332549311, ISBN-13: 978-9332549319.
2. “Algorithms” by T H Cormen, ISBN: 9788120340077, 8120340078 Edition: 3rd Edition, 2009.
3. “The C Programming Language” by B W Kernighan and D M Ritchie, ISBN: 9789332549449, 9332549443, Edition: 2nd Edition, 2015
4. “Data Structures and Algorithms Made Easy in Java: Data Structure and Algorithmic

Puzzles” by Narasimha Karumanchi, Careermonk Publications; 2nd ed. edition (16 December 2011), Language: English, ISBN-10: 8192107558, ISBN-13: 978-8192107554.

5. “Data Structures Through C in Depth” by S K Srivastava and Deepali Srivastava, ISBN-10: 8176567418, ISBN-13: 978-8176567411
6. “Data Structure and Algorithmic Thinking with Python” by Narasimha Karumanchi, ISBN-10: 8192107590, ISBN-13: 978-8192107592.

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – I**  
**ITCC13: Computer System Architecture**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

This course provides the study of the evolution of computer architecture and the factors influencing the design of hardware and software elements of computer systems. Topics may include: instruction set design; processor micro-architecture and pipelining; cache and virtual memory organizations; protection and sharing; I/O and interrupts; in-order and out-of-order superscalar architectures; VLIW machines; vector supercomputers; multithreaded architectures; symmetric multiprocessors; and parallel computers.

**Course Learning Outcomes:**

CO1: Describe the characteristics of CISC and RISC architectures

CO2: Describe the main addressing modes and their classification in CISC and RISC architectures

CO3: Describe the basic characteristics and structure of RISC and CISC instruction repertoire

CO4: Describe the principles and the functionality of the memory hierarchy (Cache, Scratch Pad)

CO5: Describe the different design options of the memory hierarchy

CO6: Describe the functionality and the characteristics of static and dynamic RAMs

CO7: Describe the design principles of Input/output

CO8: Describe the segmentation and paging techniques for memory management

CO9: Describe the characteristics and the structure of the X86 processor family architecture

CO10: Design, compile debug and execute applications written in the x86 assembly language

**Contents:**

This course provides the study of the evolution of computer architecture and the factors influencing the design of hardware and software elements of computer systems. Topics may include: instruction set design; processor micro-architecture and pipelining; cache and virtual memory organizations; protection and sharing; I/O and interrupts; in-order and out-of-order superscalar architectures; VLIW machines; vector supercomputers; multithreaded architectures; symmetric multiprocessors; and parallel computers.

### **UNIT I**

Evolution of computer architecture and the factors influencing the design of hardware and software elements of computer systems. Instruction set design; processor micro-architecture and pipelining; cache and virtual memory organizations; protection and sharing; I/O and interrupts; in-order and out-of-order superscalar architectures.

### **UNIT II**

VLIW machines; vector supercomputers; multithreaded architectures; symmetric multiprocessors; and parallel computers.

### **UNIT III**

Segmentation, Paging, CISC & RISC processors, Addressing Modes, Instruction Sets.

### **UNIT IV**

Memory Hierarchies: Cache and Scratch Pad. Memory Technologies: SRAM and SDRAM, Computer IO Interface, Buses, x86 Assembly.

### **UNIT V**

Case Studies: Case studies of some contemporary advanced architecture for processors of families like Intel, AMD, IBM etc.

### **Recommended Reading:**

1. Kai Hwang and Zhiwei Xu, Scalable Parallel Computing, McGraw-Hill, 1998
2. "Computer Architecture: A Quantitative Approach" by John L Hennessy and David A Patterson, eBook ISBN: 9780123838735 Imprint: Morgan Kaufmann Published Date: 16th September 2011 Page Count: 856
3. "Modern Processor Design: Fundamentals of Superscalar Processors" by John Paul Shen and Mikko H Lipasti, Waveland Press, Inc.; 1 edition (July 30, 2013) Language: English ISBN-10: 1478607831 ISBN-13: 978-1478607830
4. "Computer Architecture: Pipelined and Parallel Processor Design" by M J Flynn, Jones and Bartlett Publishers, Inc; First Edition edition (10 May 1995) Language: English ISBN-10: 0867202041 ISBN-13: 978-0867202045
5. "High Performance Networks: From Supercomputing to Cloud Computing" by Dennis Abts and John Kim
6. "High Performance Embedded Architectures And Compilers" by Soft Cover and J Emer, Publisher: Springer-verlag Gmbh ISBN: 9783642115141, 3642115144 Edition: 1st Edition, 2010.
7. "A High Performance Architecture for PROLOG" Dobry T P Dobry, ISBN 978-1-4613-1529-2



**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – I**  
**ITCC14: Mathematical Foundation of Computing**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

This course is about mathematical techniques that are useful in computer science, to analyze algorithms and prove impossibility results. The course will cover; introduction to the kind of discrete mathematics that is useful in computer science, including sets, graphs and proofs by induction; finite automata, which model simple linear-time algorithms and capture the power of regular expressions. It will describe the power and limitation of this class of algorithms inside out; Turing machines and undecidability, in which we study the power of arbitrary algorithms that are allowed arbitrarily large running times, complexity theory and NP-completeness, which is concerned with the study of what we can do with efficient algorithms.

**Course Learning Outcomes:**

CO1: Recognize and employ fundamental mathematical notions (sets, functions, relations, etc.) for defining and solving computational problems

CO2: Understand complex combinatorial problems and employ the combinatorial strategies introduced in the course

CO3: Understand problems in Graph Theory and devise solving strategies and techniques state and analyze correct proofs, using the fundamental techniques reviewed in the course (mathematical induction, reduction and absurdum, etc.)

CO4: understand and solve problems in elementary Number Theory and its applications

**Contents:**

Rudiments of Mathematical Logic & Set Theory: propositional logic, elements of first- order logic, the algebra of sets, finite and infinite sets, cardinality and Cantor's diagonal methods. Proof methods: mathematical induction (strong induction and well ordering principle), diagonalization, reduction and absurdum. Relations and Functions: Cartesian product, binary and n-ary relations, functions, lattices and partial orders, equivalence and congruence relations. Combinatorics: rules of sum and product, combinations and permutations (with/without repetition), balls in urns, inclusion/exclusion principle, pigeonhole principle. Rudiments of Graph Theory: graph species, Euler & Hamilton graphs and trails, planar graphs, graph coloring, matching theorems, elements of Ramsey Theory. Trees: trees and rooted trees, applications, Huffman codes. Depending on the progress, number theory and the basics of algorithm analysis can be touched upon.

**UNIT I**

Rudiments of Mathematical Logic & Set Theory: propositional logic, elements of first- order logic, the algebra of sets, finite and infinite sets, cardinality and Cantor's diagonal methods.

Proof methods: mathematical induction (strong induction and well ordering principle), diagonalization, reduction and absurdum.

## **UNIT II**

Relations and Functions: Cartesian product, binary and n-ary relations, functions, lattices and partial orders, equivalence and congruence relations. Combinatorics: rules of sum and product, combinations and permutations (with/without repetition), balls in urns, inclusion/exclusion principle, pigeonhole principle.

## **UNIT III**

Rudiments of Graph Theory: graph species, Euler & Hamilton graphs and trails, planar graphs, graph coloring, matching theorems, elements of Ramsey Theory. Trees: trees and rooted trees, applications, Huffman codes. Depending on the progress, number theory and the basics of algorithm analysis can be touched upon.

## **UNIT IV**

Recurrences: Some Basics and Examples, The Tower of Hanoi, Solving Recurrences, Connection to Divide-and-Conquer Algorithms, Iteration Example, Closed Form for Geometric Sequences, More with Tower of Hanoi, Complete Graphs and Edge Set Sizes

## **UNIT V**

Mathematical Logic and Methods of Computation (Finite State Machines, Push down Automata, Turing m/c), Regular Set, finite Automata

### **Recommended Reading:**

1. "Discrete Mathematics and its Applications" by Kenneth H Rosen, McGraw Hill Education; 7 edition (1 July 2017), Language: English, ISBN-10: 0070681880, ISBN-13: 978-0070681880
2. "Elements of Discrete Mathematics" by C L Liu Publisher: McGraw Higher Ed ISBN: 9781259006395, 1259006395, Edition: 4th Edition, 2012
3. "Discrete Mathematics for Computer Science" by Kenneth Bogart and Robert L Drysdale, McGraw Hill Education; 7 edition (1 July 2017), Language: English ISBN-10: 0070681880, ISBN-13: 978-0070681880.
4. "Discrete Mathematics with Applications" by Thomas Koshy, ISBN 978-0-12-421180-3.
5. "Discrete Mathematics and Its Applications" by Kenneth Rosen, McGraw Hill Education; 7 edition (1 July 2017), Language: English, ISBN-10: 0070681880, ISBN-13: 978-0070681880.
6. "Discrete Mathematics" by Johnsonbaugh, Prentice Hall; 24322nd edition (1994), Language: English, ASIN: B008WDTQ3Y.
7. "Discrete Mathematics" by Nicodemi O, CBS; 1st edition (2005), Language: English ISBN-10: 8123919956, ISBN-13: 978-8123919959.

**Masters in Informatics**  
**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – II**  
**ITCC21: Computer Communication and Networks**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

This course is to provide students with an overview of the concepts and fundamentals of data communication and computer networks. Topics to be covered include: data communication concepts and techniques in a layered network architecture, communications switching and routing, types of communication, network congestion, network topologies, network configuration and management, network model components, layered network models (OSI reference model, TCP/IP networking architecture) and their protocols, various types of networks (LAN, MAN, WAN and Wireless networks) and their protocols.

**Course Learning Outcomes:**

CO1: Describe several protocols and technologies (e.g., HTTP, TCP/IP and Ethernet), as well as related network applications (e.g., mail, web, file transfer, peer-to-peer)

CO2: Implement simple network applications

CO3: Explain the functions that are executed in every layer of the protocol stack (i.e., physical, data link, network, transport, application layers)

CO4: Design local area networks

CO5: Use commands to configure end terminals and network devices and analyze any network malfunction

CO6: Analyze the information located in a transmitted packet

CO7: Evaluate the efficiency of well-known network protocols

**Contents:**

Basic concepts in networking, the OSI model, error detection codes, flow control, routing, medium access control, and high-speed networks. Data communications, network architectures, communication protocols, data link control, medium access control; introduction to local area networks metropolitan area networks and wide area networks; introduction to Internet and TCP/IP. Network topology design, Network layer switching.

**UNIT I**

Basic concepts in networking, the OSI model, error detection codes, flow control, routing, medium access control, and high-speed networks. Example networks and services including prototype new technologies. These would include Frame Relay, ISDN, ATM, Wi-Fi, xDSL, WiMAX, 2G and 3G.

## **UNIT II**

Data communications, network architectures, communication protocols, data link control, medium access control; introduction to local area networks metropolitan area networks and wide area networks. Fourier analysis, Band limited signals, Maximum data rate of a channel: Transmission impairments; Attenuation distortion, Delay distortion, Dispersion, Noise: Data transmission modes; Serial & Parallel, Simplex, Half duplex & full duplex, Synchronous & Asynchronous transmission:

## **UNIT III & IV**

IPv4 and IPv6 addressing. IP protocol, IPv4 and IPv6 packet formats, subnetting, and IP routing. UDP and TCP protocols: connection management and congestion control. Address Resolution Protocol. Dynamic Host Configuration, Network Address Translation. User Datagram Protocol. Stream Control Transmission Protocol. Quality of Service, Data Traffic, Congestion, Congestion Control, Two Examples, Quality Service, Techniques to improve QoS, Integrated Services, Differentiated Services, QoS in Switched Networks

## **UNIT V**

WWW and HTTP: Architecture, Web Documents, HTTP, Network Management: SNMP, Network Management System, Simple Network Management Protocol (SNMP), Multimedia, Digitizing Audio and Video, Audio and Video Compression, Streaming Stored Audio/Video, Streaming Live Audio/Video, Real-Time Interactive Audio/Video, RTP, RTCP, Voice over IP.

### **Recommended Reading:**

1. "Data and Computer Communication" by William Stallings, ISBN-10: 0132381958 ISBN-13: 978-8120330788
2. "Data Communication and Networking" by Behrouz A Forouzan, ISBN: 9780070634145, 0070634149, Edition: 4th Edition, 2006.
3. "Computer Networks" by Andrew S Tanenbaum, Publisher: PTR PH; 3 edition (1996), ASIN: B0048FLVNS
4. "Internetworking with TCP/IP, Volume 1" by Douglas Comer, Pearson Education India; 2 edition (2014) Language: English ISBN-10: 9332535957 ISBN-13: 978-9332535954
5. "TCP/IP Illustrated" by W Richard Stevens, Publisher: PEARSON, ISBN: 9789332535954, 9332535957 Edition: 2nd, 2014
6. "Computer Networking" by James F Kurose and Keith W Ross, ISBN: 9789332585492/9788131790540, 8131790541 Edition: 5th Edition, 2012.

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – II**  
**ITCC22: Database Systems**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

This course will provide students with a general overview of databases, introducing database history, modern database systems, the different models used to design a database, and Structured Query Language (SQL), which is the standard language used to access and manipulate databases. Many of the principles of database systems carry to other areas in computer science, especially operating systems. Databases are often thought of as one of the core informatics topics, since many other areas in the discipline have been derived from this area.

**Course Learning Outcomes:**

CO1: Design all stages of a database

CO2: Express simple queries

CO3: Express complex and aggregate queries

CO4: Implement applications using database management systems

**Contents:**

Introduction to database concepts, Data organization and management techniques. Goals of DBMS including data independence consistency, Data security and Integrity. DBMS models: Hierarchical, Network and Relational, Relational algebra, Relational calculus, Query languages. Relational database design, Functional and Multi valued dependencies & normal forms. Database query optimization, Data abstraction and Modelling, ER Model, Relational Model, Hierarchical Model, Normalization, Query Processing, Crash Recovery, Concurrency Control, Distributed database, Object Oriented database, Data Mining, Multimedia Database, Digital Libraries. The entity relation model (E/R). The relational model, relational algebra and other query languages (relational calculus, Datalog, QBE). SQL. Data constraints, functional dependencies, relational database design, canonical forms. Algorithms for database design, moving from E/R to relational model. Query evaluation.

**UNIT I**

Introduction to database concepts, Data organization and management techniques. Goals of DBMS including data independence consistency, Data security and Integrity. DBMS models: Hierarchical, Network and Relational, Relational algebra, Relational calculus, Query languages. Relational database design, Functional and Multi valued dependencies & normal forms.

**UNIT II**

Database query optimization, Data abstraction and Modelling, ER Model, Relational Model, Hierarchical Model, Normalization, Query Processing, Crash Recovery, Distributed database, Object Oriented database, Data Mining, Multimedia Database, Digital Libraries.

### **UNIT III**

The entity relation model (E/R). The relational model, relational algebra and other query languages (relational calculus, Datalog, QBE). SQL. Data constraints, functional dependencies, relational database design, canonical forms. Algorithms for database design, moving from E/R to relational model. Query evaluation.

### **UNIT IV**

Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.

### **UNIT V**

The importance of data models, Basic building blocks, Business rules, The evolution of data models, Degrees of data abstraction.

#### **Recommended Reading:**

1. "Database System Concepts" by Abraham Silberschatz and S Sudarshan, McGraw Hill Education; Sixth edition (1 December 2013), Language: English, ISBN-10: 9332901384 ISBN-13: 978-9332901384.
2. "Database Management Systems" by Raghu Ramakrishnan, ISBN-10: 007123151X ISBN-13: 978-0071231510
3. "An Introduction to Database Systems" by Bipin Desai, ISBN-10: 8175156171 ISBN-13: 978-8175156173.
4. "Principles of Database Systems" by J D Ullman, ISBN-10:8175155450, ISBN-13:9788175155459.
5. "Fundamentals of Database Systems" by R Elmasri and S Navathe, ISBN: 9789332582705, 933258270X ,Edition: Seventh, 2017.
6. "Foundations of Databases" by Serge Abiteboul and Victor Vianu, Pearson; 1 edition (December 2, 1994) Language: English ISBN-10: 0201537710 ISBN-13: 978-201537710.

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – II**  
**ITCC23: Operating Systems**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

Operating systems (OS) provide the crucial interface between a computer's hardware and the applications that run on it. It allows us to write programs without bothering much about the hardware. It also ensures that the computer's resources such as its CPU, hard disk, and memory, are appropriately utilized. In this course, we dwell into how the OS manages to do all this in an efficient manner. This is an introductory course, for students with prior knowledge of computer organization. The course is based on an OS called xv6, which in many ways is similar to the Linux operating systems.

**Course Learning Outcomes:**

CO1: Describe the goals of the operating system, its structure and the main types of operating systems.

CO2: Describe the modelling of processes, their switching on the CPU, the mechanisms for accomplishing inter process communication and synchronization and the basic algorithms for process scheduling; apply the related algorithms and solve related problems.

CO3: Describe the concept of deadlock, the related problems, the mitigation strategies and the algorithms used to this end. The student will be also able to apply the related algorithms.

CO4: Describe the goals of memory management, the main techniques for managing memory and the related algorithms. The student will be also able to apply the related algorithms.

CO5: Describe the basic elements and the functionality of file systems, their structures, their implementation methods and the related techniques and algorithms and solve related problems.

CO6: Describe the principles and structure of input/output software, and the way that input/output soft- ware handles the main device categories.

CO7: Describe the concepts of security related to the operating system, the existing threats and the mitigation methods and mechanisms, and additionally choose and apply the related algorithms.

**Contents:**

Overview of operating systems concepts and elements of computer architecture. Operating system structure. Processes: states, synchronization and scheduling. Deadlocks and deadlock handling. Memory management. Input-output management. Disk devices and file systems. Security. UNIX system tools, Programming language interface, awk, lex, yacc, File and Shared Libraries, Inter process communication, Common object file format, Sdb, Link, Make source code control system, Programmers productivity tools, Extended terminal interface, D Security, X Windows.

## **UNIT I**

Overview of operating systems concepts and elements of computer architecture. Operating system structure. Processes: states, synchronization and scheduling. Deadlocks and deadlock handling. Memory management. Input-output management. Disk devices and file systems. Security.

## **UNIT II**

UNIX system tools, Programming language interface, awk, lex, yacc, File and Shared Libraries, Inter process communication, Common object file format, Sdb, Link, Make source code control system, Programmers productivity tools, Extended terminal interface, D Security, X Windows.

## **UNIT III**

File concept, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency & performance.

## **UNIT IV**

Security & Protection Security Environment, Design Principles Of Security, User Authentication, and Protection Mechanism: Protection Domain, Access Control List

## **UNIT V**

Interprocess Communication Race Conditions, Critical Section, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dining Philosopher Problem etc., Scheduling, Scheduling Algorithms.

### **Recommended Reading:**

1. "Operating System Concepts" by Avi Silberschatz and Peter Galvin, ISBN-10: 0471489050 ISBN-13: 978-0471489054.
2. "Operating Systems: Internals and Design Principles" by William Stallings, ISBN-13: 978-0471489054 ISBN-10: 0471489050
3. "Operating Systems: A Concept-Based Approach" by D M Dhamdhere, ISBN: 9781259005589, 1259005585 Edition: 3rd Edition.
4. "Operating System: A Design-oriented Approach" by Charles Crowley, ISBN: 9780074635513, 0074635514, Edition: 1st Edition, 2009
5. "Operating Systems: A Modern Perspective" by Gary J Nutt, ISBN-13: 978-0805312959 ISBN-10: 0805312951.
6. "Design of the Unix Operating Systems" by Maurice Bach, ISBN: 9789332549579, 8131771687 Edition: First, 2015.



**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – II**  
**ITCC24: Applied Machine Learning**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

The course gives an introduction to machine learning techniques and theory, with a focus on its use in practical applications. During the course, a selection of topics will be covered in supervised learning, such as linear models for regression and classification, or nonlinear models such as neural networks, and in unsupervised learning such as clustering. The use cases and limitations of these algorithms will be discussed, and their implementation will be investigated in programming assignments. Methodological questions pertaining to the evaluation of machine learning systems will also be discussed, as well as some of the ethical questions that can arise when applying machine learning technologies.

**Course Learning Outcomes:**

CO1: explain the scope, goals and limits of machine learning, and the main sub-areas of the field.

CO2: describe the various techniques covered in the syllabus and where they fit within the structure of the discipline.

CO3: able to critically compare, contrast and evaluate the different ML techniques in terms of their applicability to different Machine Learning problems.

CO4: able to use appropriate software to apply these techniques to the data set to solve the problem.

CO5: able to use a systematic approach to conducting experimental investigations and assessing scientific hypotheses.

**Contents:**

Introductory Lecture, Maths and Probability, Thinking About Data, Naive Bayes, Decision Trees, Generalisation and Evaluation, Linear Regression, Logistic regression, Optimisation and Regularisation, Support Vector Machines, Nearest Neighbours, K-Means, Gaussian Mixture Models, Principal Components Analysis, Hierarchical Clustering, Neural Networks

**UNIT I**

Introductory Lecture, Maths and Probability, Thinking About Data, Naive Bayes, Decision Trees, Generalisation and Evaluation, Linear Regression, Logistic regression, Optimisation and Regularisation.

**UNIT II**

Support Vector Machines, Nearest Neighbours, K-Means, Gaussian Mixture Models, Principal Components Analysis, Hierarchical Clustering, Neural Networks.

### UNIT III

Rule Learning: Propositional and First-Order: Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Horn-clause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution, Golem, and Progol.

### UNIT IV

Artificial Neural Networks:

Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.

### UNIT V

Language Learning:

Classification problems in language: word-sense disambiguation, sequence labeling. Hidden Markov models (HMM's). Viterbi algorithm for determining most-probable state sequences. Forward-backward EM algorithm for training the parameters of HMM's. Use of HMM's for speech recognition, part-of-speech tagging, and information extraction. Conditional random fields (CRF's). Probabilistic context-free grammars (PCFG). Parsing and learning with PCFGs. Lexicalized PCFGs.

### Recommended Reading:

1. "Elements of Statistical Learning" by Hastie, Tibshirani, Friedman, ISBN-10: 1461471370, ISBN-13: 978-1461471370.
2. "Machine Learning and Bayesian Reasoning" by David Barber, ISBN: 9781107439955, 1107439957.
3. "Gaussian Processes for Machine Learning" by Rasmussen and Williams, Carl Edward Rasmussen and Christopher K. I. Williams The MIT Press, 2006. ISBN 0-262-18253-X.
4. "Information Theory, Inference, and Learning Algorithms" by David MacKay, ISBN-10: 0521642981 ISBN-13: 978-0521642989.
5. "Introduction to Machine Learning" by Smola and Vishwanathan.
6. "A Probabilistic Theory of Pattern Recognition" by Devroye, Györfi, Lugosi, ISBN 978-1-4612-0711-5

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – III**  
**ITCC31: Software Engineering**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

You will develop skills in analysing requirements and designing appropriate software solutions; designing and creating complex software systems to solve real-world problems, evaluating and using advanced software engineering environments, design methods and programming languages, and evaluating and responding to recent trends in interoperability and software development. The course covers significant trends in systems development, including service-oriented architecture; cloud computing, and big data.

**Course Learning Outcomes:**

CO1: Describe the goals of software engineering, the basic concepts, the methodologies used and the tools supporting them; additionally,

CO2: Describe the aspects that should be taken into account while developing software (usability, performance, human and organizational factors etc.) as well as the impact of each aspect

CO3: Describe the software life cycle, the phases it comprises of and the activities taking place in each phase and be able to shape the life cycle of a small scale software development project

CO4: Describe and create/use the most commonly used UML diagrams (use case diagrams, class diagrams, sequence diagrams, state machine diagrams, deployment diagrams)

CO5: Explain the processes of requirement elicitation and analysis and the tools they use and be able to perform these processes

CO6: Explain the design processes, the tools and the criteria used therein, and be able to design a system

CO7: Explain and carry out the processes and techniques of writing code according to the design and testing the code

CO8: Explain how a software development project is organized and the structure of communication among the project participants.

**Contents:**

Introduction. Software development paradigms – software life cycle models. Re- quirements – analysis, specification and validation. Design. Software architecture. Detailed design. Implementation and testing. Project organization and phases, team organization and communication.

**UNIT I**

The Evolving role of Software, The changing Nature of Software, Legacy software, A generic view of process, A layered Technology, A Process Framework, The Capability Maturity Model Integration (CMMI), Process Assessment, Personal and Team Process Models, Product and

Process, Process Models, Evolutionary Process Models, Prototyping, The Concurrent Development Model, Specialized Process Models, the Unified Process.

## **UNIT II**

Business Process Engineering, Requirements Engineering, System Modelling, Requirement Analysis concepts and Principles, Software Prototyping, Software Requirement Specification, Data Modelling, Functional Modeling and Information Flow, Behavioral Modelling, Architectural Design,

## **UNIT III**

Surveys of software design methods, Software design quality (Cohesion and Coupling), Design by contract. Software architecture. Detailed design. Implementation and testing. Project organization and phases, team organization and communication, Version Control.

## **UNIT IV**

Testing & maintenance: Testing strategies- Testing Tactics - strategies Issues for conventional and object oriented software-Verification and Validation- validation testing –system testing –Art of debugging.

## **UNIT V**

Software Quality, Technical Metrics for Software, Metrics for Design Model, Business Process Reengineering, Reverse Engineering and Restructuring, Software Economics, Client/Server Software Engineering, Web Engineering

### **Recommended Reading:**

1. “Software Engineering, A practitioner’s Approach” by Roger S. Pressman, McGrawHill International Edition, 6th Edition, ISBN-10: 0071267824, ISBN-13: 978-0071267823.
2. “Software Engineering” by Sommerville, Pearson Education, 7th edition, ISBN-10: 8177585304, ISBN-13: 978-8177585308.
3. “Software Engineering” by K.K. Aggarwal & Yogesh Singh, New Age International Publishers, ISBN: 9788122423600, 8122423604, Edition: 3rd Edition, 2008
4. “Software Engineering”, An Engineering Approach by James F. Peters, Witold Pedrycz, John Wiley, ISBN: 978-0-471-18964-0, Dec 1999
5. “Software Engineering principles and practice” by Waman S Jawadekar, The McGraw-Hill Companies, ISBN-10: 0070583714, ISBN-13: 978-0070583719.
6. Timothy C. Lethbridge & Robert Laganière. “Object-Oriented Software Engineering: Practical Software Development using UML and Java (Second Edition)”. McGraw-Hill, 2005.

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – III**  
**ITCC32: Information System Design**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

Information Systems design is a set of procedures performed to convert the logical specification into a design that can be implemented on the organization's computer system. Systems implementation is a set of procedures performed to complete the design contained in the approved systems design document and to test, install, and begin to use the new or revised Information System. This course focuses on the design of information systems. Through current design and development environments, students will be exposed to a number of experiential learning elements to assist with the understanding and development of necessary skills for information systems design. The student will gain practical experience in modelling, design and the construction of an integrated prototype.

**Course Learning Outcomes:**

CO1: Follow the Design Thinking Process to create an information systems design,

CO2: Create an Information Model based on design patterns including Objects/Events, Par and Inheritance.

CO3: Evaluate the user experience of an existing information system based on a predefined but open-ended rubric.

CO4: Demonstrate and document an information system design by creating a, forms based prototype for to support business processes, 3D graphical prototype, Report containing appropriate analysis and design artefact,

CO5: Create visualisations to show how with appropriate tools and environments end users can explore and add value to data for themselves,

CO6: Propose design elements for emerging technologies,

CO7: Prepare, plan and execute a systems design using a collaborative environment, Research and present an evaluation of components, such as machine learning, to be used in a systems design.

**Contents:**

Design Thinking, Information Modelling, Prototyping and Parts of Things Design Pattern, Generalisation and True Graphical UI, Samples and Source Code, Simulators and Emulators, Debugging Code with modern tools, Cognitive Services, Cognitive Services, BOTs, Information Design Principles

**UNIT I**

Design Thinking, Information Modelling, Prototyping and Parts of Things Design Pattern, Generalisation and True Graphical UI, Samples and Source Code.

## **UNIT II**

Simulators and Emulators, Debugging Code with modern tools, Cognitive Services, Cognitive Services, BOTs, Information Design Principles.

## **UNIT III**

Foundations of systems development, Systems Development Processes, Management of systems development projects, Structured analysis.

## **UNIT IV**

Structured design of data, Object-Oriented Analysis and Design, Design of user interfaces, Implementation and Maintenance.

## **UNIT V**

Systems Analysis and Design Life Cycle: Requirements determination – requirements specifications – feasibility analysis – final specifications – hardware and software study – system design – system implementation – system evaluation – system modification. Role of systems analyst – attributes of a systems analyst – tools used in system analysis

### **Recommended Reading:**

1. Designing Information Systems, 1st Edition, Authors: Stanley G. Blethyn Carys Y. ParkereBook ISBN: 9781483183855
2. Information Systems Analysis and Modeling: An Informational Macrodynamics Approach by Vladimir S. Lerner, Publisher: Springer; 1st ed. 2000 edition, ISBN-10: 1461370981, ISBN-13: 978-1461370987
3. Fundamentals of Information Systems, Ralph M. Stair, Publisher: Course Technology; 3rd Revised edition edition (1 April 2005), ISBN-10: 0619215607, ISBN-13: 978-0619215606.
4. “Systems Analysis and Design” by Dennis and Wixom, ISBN: 978-1-118-89784-3, Nov2014
5. “Systems Analysis and Design” by Goyal A, ISBN: 9788126562954. Publisher: Wiley
6. “Systems Analysis and Design” by Elias M Award, ISBN 10: 817515618X / ISBN 13: 9788175156180 Published by Galgotia Publications Pvt Ltd, 1997

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – III**  
**ITCC33: IT Planning & Management**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

Information Technology (IT) changes the manner and scope in which businesses operate and compete. Innovations in IT have led some businesses to flourish, while others have faltered due to massive changes brought by this industry. IT is notoriously hard to manage. The challenge of planning and managing IT is ensuring that the intended changes and innovations are realized, and the unintended ones are kept under control. This course will cover concepts of information technology planning and management.

**Course Learning Outcomes:**

CO1: Able to contribute to IS planning and strategy formulation in corporate enterprises and complex administrations.

CO2: Will have a deep understanding of a socio-technical approach to the deployment of information technology in modern organisations.

CO3: Will have an understanding of frameworks for analysing strategic issues of IS deployment and a familiarity with the most cogent current issues.

CO4: Will develop insight into cases of the strategic planning of information systems often demand

CO5: Will be confident in addressing an audience and skills of explanation and persuasion.

**Contents:**

IS, IM, IT Strategy, Alignment and Maturity, Packages and Information Infrastructures, The CIO and IT Governance, Knowledge Management, Outsourcing and Offshoring, Evaluation and Risk Management.

**UNIT I**

IT and Software, IT characteristics and applications, IT Processes, Methods, and Tools, A Generic View of IT Management, IT Manager role definition and KRAs, understanding evolving IT Landscape, IT and networking as applied to enterprises in public and commercial sector.

**UNIT II**

Software Management, Software Lifecycle, Software Process and Project Metrics, Software Quality Management and Assurance, Software Configuration Management, Software Sizing, Cost Estimation, The Make/Buy Decision, Automated Estimation Tools

**UNIT III**

Project Planning and Management Concepts, Project Scheduling and Tracking, Acceptance Management, Change Management, Configuration Management, Issues Management,

*Course Revision Ver. 1.1a.2018 (IIC, UDSC)*

Communication Management, Expectation Management, Quality Management, Requirements Management, Risk Analysis and Management, Project Control and Reporting Audits, Review Process.

#### **UNIT IV**

IT-enabled products or services, ITIL Service Management Model, IT Service Strategy, IT service Design, IT Service Operation, IT Service Transition, IT Service Desk, The Deming Cycle, Service Measurement, Service Level Management, Continual Service Improvement, Asset Management, Demand management, Using ITSM to reduce costs, Frameworks, Models, Standards and Quality Systems.

#### **UNIT V**

Common IT Setups and Systems, Fundamental aspects of daily IT operations, human factors in organization, acquisition and procurement, research and Development, Logical planning, Relations with OEMs, Managing digital networks and security, Management Information Systems, Strategic planning in regulated and competitive IT industries, the management and marketing of a technology based enterprise, the strengths and weaknesses of different Management and Marketing approaches, their legal constraints, responsibilities and ethics, Social and ethical aspects of IT, The principles and methods of asset valuation, Interpretation and measurement, Financial statements risk assessment, Capital market, Capital budgeting and the effects of economic regulation on capital formation, IT Policy and Regulation

#### **Recommended Reading:**

1. **Managing the Internet of Things: Architectures, Theories, and Applications** Editors: Jun Huang & Kun Hua, Chongqing University, China & Lawrence Technological University, USA, ISBN9781785610288.
2. **“Management”** by Stoner J A and Freeman R E, ISBN 10: 8131707040 / ISBN 3: 9788131707043
3. **“Management: Principles and Practice”** by S K Mandal ISBN: 9788184952209, 8184952201 Edition: 1stEdition, 2011, Pages: 500.
4. **“Principles and Practices of Management”** by Khusboo Manoj ISBN-10: 9380921128 ISBN-13: 978-9380921129.
5. **“Principles and Practice of Sport Management”** by Carol A Barr, ISBN-13: 9781284034172 Product With Access Code, 606 pages.
6. **“Better Software Practice for Business Benefit: Principles and Experiences”** by Colin Tully and Richard Messnarz, ISBN-10: 0769500498 ISBN-13: 978-0769500492.



**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – IV**  
**ITCC41: Research Methods in Informatics**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

This course provides an overview on research goal settings and research methodologies practiced in Informatics, focusing on the properties inherent in those research methods. Namely, we will address methods to extract information and knowledge represented in varied conformations, procedures to study them, and analytical techniques to interpret the results. Individual research methods are treated through case studies.

**Course Learning Outcomes:**

CO1: Explain the importance of informatics for research,

CO2: Illustrate the scientific method and compare different research method,

CO3: Identify a research problem and formulate hypotheses,

CO4: Analyze the literature and summarize the state of the art,

CO5: Design a scientific study, choose a methodology, and create a model, Plan an experiment and prioritize objectives,

CO6: Test hypotheses, measure data, and analyze dynamics, Organize results, elaborate conclusions, and defend a thesis,

CO7: Analyze data and make use of strategies to simplify interpretation, Design scientific exploitation strategies

CO8: Organize and deliver scientific presentation, Identify commercial exploitation strategies

**Contents:**

Informatics in research, Research methods, Reviewing the state of the art, Quantitative research design, Sampling, Data acquisition, Qualitative research design, Experimental research design, Data analysis: basic statistics, Data analysis: advanced statistics, Results and discussion, Scientific writing, Research as a creative process, Scientific presentations, From research to business, Final project presentation and discussion

**UNIT I**

Informatics in research, Research methods, Reviewing the state of the art, Quantitative research design, Sampling, Data acquisition, Qualitative research design, Experimental research design.

**UNIT II**

Data analysis: basic statistics, Data analysis: advanced statistics, Results and discussion, Scientific writing, Research as a creative process, Scientific presentations, from research to business, Final project presentation and discussion

### **UNIT III**

Data acquisition: introduction to validity, judgmental validity, empirical validity, judgmental-empirical validity, reliability and its relationship to validity, measures of reliability, internal consistency and reliability, norm- and criterion-referenced tests, measures of optimum performance, measures of typical performance, measurement in qualitative research

### **UNIT IV**

Qualitative research design: interviews in qualitative research, other methods for collecting, qualitative data, grounded theory and research design, consensual qualitative research design, designing case study research, mixed methods designs. Experimental research design: true experimental designs, threats to internal validity, threats to external validity, pre-experimental designs, quasi-experimental designs, confounding in experiments

### **UNIT V**

Research as a creative process: multidisciplinary research, creative problem solving strategies, novel research practices, game theory, machine learning, dynamics and paradigms in scientific publishing. Scientific presentations: how to prepare a scientific presentation, scientific content delivery, data visualization

#### **Recommended Reading:**

1. Patten and Newhart, Understanding Research Methods: An Overview of the Essentials, 10th edition (2017), ISBN-10 0415790522, ISBN-13 978-0415790529.
2. “Visual Research: An Introduction to Research Methods in Graphic Design (Required Reading Range)” by Russell Bestley and Ian Noble, ISBN 9781474232906
3. S. T. March and G. F. Smith. Design and natural science research on information technology. Decision Support Systems, 15:251–266, 1995.
4. H. Simon. The Sciences of the Artificial. Cambridge, MA, MIT Press, 1996, ISBN: 9780262190510
5. V. Vaishnavi and W. Kuechler. Design Research in Information Systems. [www.isworld.org/Researchdesign/drisISworld.htm](http://www.isworld.org/Researchdesign/drisISworld.htm)

#### **Supplementary book(s) and article(s):**

Springer’s tutorial on scientific writing <https://www.springer.com/us/authors-editors/authorandreviewertutorials/writing-a-journal-manuscript>

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – IV**  
**ITCC42: Internet of Things Systems, Security and Cloud**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

This course will give students a theoretical and practical grounding in Internet of Things (IoT), covering IoT systems architecture, hardware platforms, embedded programming and debugging, networking paradigms for IoT, secure operation, cloud integration, and simple data analytics. The coursework component, by which students will work in pairs and design, build, evaluate, document, and demonstrate an IoT prototype.

**Course Learning Outcomes:**

- CO1: Acquire good understanding of the Internet of Things concept and systems architecture;
- CO2: Operate with wireless technologies and networking protocols specific to IoT systems;
- CO3: Become familiar with standard security and privacy preserving mechanisms, and understand different cloud integration methods;
- CO4: Design, implement, and test a simple IoT system equipped with sensors and wireless transceivers;
- CO5: Write technical documentation of a research project and results obtained by means of experiments in a workshop style paper format.

**Contents:**

IoT systems architecture, hardware platforms, relevant wireless technologies and networking protocols, security and privacy concepts, device programming and debugging, cloud integration, simple data analytics, and commercialisation challenges.

**UNIT I**

IoT systems architecture, hardware platforms, relevant wireless technologies and networking protocols, security and privacy concepts, device programming and debugging, cloud integration, simple data analytics, and commercialisation challenges.

**UNIT II**

Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Machine to Machine, Difference between IoT and M2M, Software define Network.

**UNIT III**

Design challenges, Development challenges, Security challenges, Other challenges, Home automation, Industry applications, Surveillance applications, Other IoT applications

## UNIT IV

Developing IoTs: Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python

## UNIT V

Cloud Computing Basics, Software as a Service (Saas), Platform as a Service (PaaS), Infrastructure as a Service (IaaS), Securing the Cloud, Service Oriented Architecture, Developing Applications, Migrating to the Cloud, Designing Cloud Based Solutions

### Recommended Reading:

1. Internet of Things 1st Edition Principles and Paradigms by Rajkumar Buyya Amir Vahid Dastjerdi, eBook ISBN: 9780128093474 ISBN: 9780128053959.
2. Internet-of-Things (IoT) Systems Architectures, Algorithms, Methodologies by Serpanos, Dimitrios, Wolf, Marilyn, ISBN 978-3-319-69715-4.
3. Practical Internet of Things Security by Brian Russell, Drew Van Duren, ISBN-10: 178588963X ISBN-13: 978-1785889639
4. Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security by Perry Lea, ISBN-10: 1788470591 ISBN-13: 978-1788470599.
5. Internet of Things: A Hands-On Approach Paperback – 2015 by Arsheep Bahga, Vijay Madiseti. ISBN-10: 8173719543 ISBN-13: 978-8173719547.
6. Designing The Internet of Things by Adrian McEwen Hakin Cassimally, ISBN-10: 8126556862, ISBN-13: 978-8126556861

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Semester – IV**  
**ITCC43: Project**

**Marks: 100**

**Duration: 60 Hrs**

### Course Objectives:

The project is an essential component of the course. It is a substantial component of full-time independent work, which occupies the final months of the course. A dissertation describing the work is required to be submitted by the student.

### Course Learning Outcomes:

- CO1: to gain practical experience with the development of a project development process
- CO2: covering the whole life-cycle of the project.
- CO3: team building exercise
- CO4: will develop applied skills in project planning, development and management

*Course Revision Ver. 1.1a.2018 (IIC, UDSC)*

**Contents:**

In this course (project), students will work in groups to carry out the project. The Institute will present a list of available projects. Students are required to work on their project and to attend common activities and supervision meetings. The results from each phase must be clearly documented. During the semester all the groups must deliver a mid-term progress report that must be approved. Projects must be presented orally after delivery.

**Recommended Reading:** To be announced before beginning of the course.

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Elective Courses**  
**ITEC01: Embedded System Design**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

This course provides fundamental requirements of embedded systems and the interaction between hardware and software in such systems. The students will be exposed to the very important issue of designing for less power consumption and introduce them to the techniques. The course also describes the traditionally distinct fields of software and hardware design in a new unified approach. It covers trends and challenges, introduces the design and use of single-purpose processors ("hardware") and general-purpose processors ("software"), describes memories and buses, illustrates hardware/software tradeoffs using a digital camera example, and discusses advanced computation models, control systems, chip technologies, and modern design tools.

**Course Learning Outcomes:**

CO1: Understand fundamental differences between conventional computing systems and embedded systems.

CO2: Apply methods and techniques for specification, designing and implementation of embedded systems.

CO3: Extend the already existing programming knowledge to the embedded systems programming

CO4: Combine already existing knowledge from obtained both Hardware and Software courses

CO5: Utilize both electronic components and software for implementation of practical embedded systems

**Contents:**

Applications of embedded systems in informatics and telecommunications (wireless sensors), signal processing (e.g. smart cards), automata automotives, Biomedical etc., Models for the description of embedded systems: computation models, High level Programming languages.

*Course Revision Ver. 1.1a.2018 (IIC, UDSC)*

Analysis and design of an application/program: program models high level transformations, Compilers for embedded systems optimisation of code Design Platforms, Partitioning of hardware and soft- ware, Performance analysis, Hardware-Software co-synthesis algorithms, Firmware development, Procedures and their time schedule, OS kernels of real time systems Hardware-Software co-design, Prototyping technologies of embedded systems, multi-processors architectures. (MPSOC), Processing units, Interconnection networks and topologies, Memory hierarchies, Memory management units. Embedded Systems Hardware: Building components of embedded systems: Microcontrollers, IP cores, Memory systems, Bridges, Peripherals, Embedded Systems implementation technologies, Low power consumption systems, Systems on Chip. Embedded Systems Software: Embedded real time OS kernels, time schedule of real time systems. Implementation of embedded systems

### **UNIT I**

Applications of embedded systems in informatics and telecommunications (wireless sensors), signal processing (e.g. smart cards), automata automotive, Biomedical etc., Models for the description of embedded systems: computation models, High level Programming languages. Analysis and design of an application/program: program models high-level transformations.

### **UNIT II & III**

Compilers for embedded systems optimisation of code Design Platforms, Partitioning of hardware and software, Performance analysis, Hardware-Software co-synthesis algorithms, Firmware development, Procedures and their time schedule, OS kernels of real time systems Hardware-Software co-design, Prototyping technologies of embedded systems, multi-processors architectures. (MPSOC), Processing units, Interconnection networks and topologies, Memory hierarchies, Memory management units.

### **UNIT IV & V**

Embedded Systems Hardware: Building components of embedded systems: Microcontrollers, IP cores, Memory systems, Bridges, Peripherals, Embedded Systems implementation technologies, Low power consumption systems, Systems on Chip. Embedded Systems Software: Embedded real time OS kernels, time schedule of real time systems. Implementation of embedded systems Verification: Verification of hybrid systems, Simulation and emulation, Testing, Fault simulation, Risk analysis, Reliability. Lab Exercises: Implementation of applications in hardware and firmware on FPGA development boards.

### **Recommended Reading:**

1. "Embedded System Design" by Peter Marwedel, ISBN 978-94-007-0257-8
2. "Computers as Components: Principles of Embedded Computing Systems Design" by Wayne Wolf, ISBN-13: 978-1558605411, ISBN-10: 155860541X
3. "Embedded System Design: A Unified Hardware/Software Introduction" by Frank Vahid and Tony Givargis, ISBN-10: 812650837X, ISBN-13: 978-8126508372
4. "Embedded Systems: A Contemporary Design Tool" by James K Peckol, ISBN: 978-0-471-72180-2

5. "The 8051 Microcontroller and Embedded Systems Using Assembly and C" by Muhammad Ali Mazidi, ISBN-10: 8131710262, ISBN-13: 978-8131710265
6. "Fundamentals of Microcontrollers and Applications In Embedded Systems" by amesh Gaonkar, ISBN:1401879144

**Masters of Science in Informatics – M.Sc. (Informatics)**

**Elective Courses**

**ITEC02: Data Analytics and Visualisation**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

Data and visual analytics is an emerging field concerned with analyzing, modeling, and visualizing complex high dimensional data. This course will introduce students to the field by covering state-of-the-art modeling, analysis and visualization techniques. It will emphasize practical challenges involving complex real world data and include several case studies and hands-on work with the R programming language, Matlab etc.

**Course Learning Outcomes:**

CO1: interpret what goes behind the processing of huge volumes of data and real-time analytics

CO2: apply computer science principles relating to data retrieval, representation, programming, and analysis.

CO3: understand and apply mathematical and statistical models and concepts to detect patterns in data, and to draw inferences and conclusions supported by data.

CO4: critical thinking skills associated with problem identification, problem solving and decision making,

CO5: assessing value propositions supported by data, and generating a logical synthesis of information from data.

CO6: apply knowledge gained from one area to problems and data in another.

**Contents:**

Introduction to Data Mining, Relationships and Representations, Graph Databases, Messaging and NoSQL storage systems, Language processing, Natural Language Understanding and Computational Semantics, Information Visualization.

**UNIT I**

Introduction to Data Mining, Relationships and Representations, Graph Databases, Messaging and NoSQL storage systems, Language processing, Natural Language Understanding and Computational Semantics, Information Visualization.

## UNIT II

Regression: Linear models, ordinary least squares, ridge regression, LASSO, Gaussian Processes regression. - Supervised classification methods: K-nearest neighbor, naive Bayes, logistic regression, decision tree, support vector machine. Sparse coding and dictionary learning, orthogonal matching pursuit. - Introduction to artificial neural networks (ANNs), deep NNs, convolutional neural network (CNN), and other recent topics.

## UNIT III

Data visualization: Basic principles, categorical and continuous variables. Exploratory graphical analysis. Creating static graphs, animated visualizations loops, GIFs and Videos. Data visualization in Python and R, examples from Bokeh, Altair, ggPlot, ggplot2, gganimate, ImageMagick etc.

## UNIT IV

Clustering techniques: K-means, Gaussian mixture models and expectation-maximization, agglomerative clustering, evaluation of clustering - Rand index, mutual information based scores, Fowlkes-Mallows index etc

## UNIT V

Visualization tools: Basic plots, Visualizing distributions, Visualizing patterns, Dimension reduction. Analytics tools: Predictive analytics, Bayes methods, Linear discriminant analysis, Logistic regression, Classification trees v. Model evaluation and validation

### Recommended Reading:

1. Fast algorithms for mining association rules, Agrawal and Srikant, VLDB 1994.
2. Data Mining Concepts and Techniques, Jiawei Han and Micheline Kamber, Morgan Kaufmann Visualization.
3. A Tour through the Visualization Zoo. Jeffrey Heer, Michael Bostock, Vadim Ogievetsky. Communications of the ACM, 53(6), pp. 59-67, Jun 2010.
4. The Value of Visualization. Jarke van Wijk. Proceedings of the IEEE Visualization Conference, pp. 79-86, 2005.
5. Ware, Colin (2004). Information Visualization: Perception for Design. London: Elsevier Science & Technology. ISBN: 9781558608191.
6. "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data" by EMC Education Services, ISBN: 978-1-118-87613-8
7. "Tableau Your Data: Fast and Easy Visual Analysis with Tableau Software" by Daniel G Murray ISBN: 978-1-119-00119-5.

**Other useful reading:** Hadoop: The Definitive Guide



**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Elective Courses**  
**ITEC03: Cloud Computing**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

In this course we cover a multitude of technologies that comprise the modern concept of cloud computing. In order to successfully design and build scalable systems on clouds, a range of knowledge and skills are needed. This module will introduce and examine cloud computing. It will describe the software components from which cloud infrastructure and platforms are constructed. Methods for building scalable cloud applications will be described and explained. Case studies drawn from industrial applications of cloud computing will be used throughout to motivate the exploration of clouds.

**Course Learning Outcomes:**

CO1: Comprehensively understand History,

CO2: Characteristics and General Benefits and Architecture of Cloud Computing and XaaS  
Cloud Based Service Offerings

CO3: Understand Cloud Service & Deployment Models, Infrastructure, and Consumer View

CO4: Design basic Cloud Applications

CO5: Understand basics of Converged Networks and Data Center Virtualization

**Contents:**

Cloud Computing Architecture: Infrastructure, Platforms and Software, Cloud Platform Components for Processing and Storage, Virtual Machines, Scalable Computing Patterns for the Cloud, Cloud Computing Case Studies

**UNIT I**

Cloud Computing Architecture: Infrastructure, Platforms and Software, Cloud Platform Components for Processing and Storage, Virtual Machines, Scalable Computing Patterns for the Cloud, Cloud Computing Case Studies.

**UNIT II**

Cloud Computing Architecture: Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models (XaaS): Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), Deployment Models, Public cloud, Private cloud, Hybrid cloud, Community cloud.

**UNIT III**

Infrastructure as a Service(IaaS): Introduction to IaaS, IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image,

Virtual Machine(VM), Resource Virtualization, Server, Storage, Network, Virtual Machine(resource) provisioning and manageability, storage as a service, Data storage in cloud computing(storage as a service), Examples: Amazon EC2, Renting, EC2 Compute Unit, Platform and Storage, pricing, customers, Eucalyptus

#### **UNIT IV**

Platform as a Service(PaaS): Introduction to PaaS, What is PaaS, Service Oriented Architecture (SOA), Cloud Platform and Management, Computation, Storage, Examples: Google App Engine, Microsoft Azure, Salesforce.com, Force.com platform

#### **UNIT V**

Software as a Service(PaaS): Introduction to SaaS, Web services, Web 2.0, Web OS, Case Study on SaaS, Service Management in Cloud Computing, Service Level Agreements(SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting enormously, Managing Data, Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing.

#### **Recommended Reading:**

1. "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, ISBN: 9780133387568.
2. "The Little Book of Cloud Computing" by Lars Nielsen, ISBN-10: 0615924220, ISBN-13: 978-0615924229
3. "Cloud Computing Explained" by John Rhoton, ISBN-10: 0956355609, ISBN-13: 978-0956355607.
4. "Cloud Computing for Programmers" by Daniele Casal
5. "Cloud Computing For Dummies" by Judith Hurwitz, ISBN-13: 978-0470484708 ISBN-10: 0470484705
6. "Cloud Computing: From Beginning to End" by Mr Ray J Rafaels, ISBN-10: 1511404582, ISBN-13: 978-1511404587.

### **Masters of Science in Informatics – M.Sc. (Informatics)**

#### **Elective Courses**

#### **ITEC04: Health Informatics**

**Marks: 100**

**Duration: 60 Hrs**

#### **Course Objectives:**

The course objective intends to impart knowledge and practical skills to understand the various aspects in the application of healthcare informatics to provide correct information to the right person at the right time, specifically by; Providing scientific education that compliments the theoretical foundation; Enhancing specialized knowledge of health informatics; Equipping students with practical skills and analytical approaches to identify and deliver healthcare IT needs.

**Course Learning Outcomes:**

CO1: To understand the intersection of information science, informatics and health care

CO2: Able to deal with the resources, devices, and methods required in optimizing the acquisition, storage, retrieval

CO3: Use of information in health and biomedical science

CO4: Able to develop high tech systems that allow for real-time communication, diagnosis, and consultation using video, audio, and web-based technologies.

CO5: Understand the systems that adhere to policies and procedures for handling information to ensure patient privacy and overall security requirements.

**Contents:**

Health Informatics, Healthcare Management, Medical Language, Data Analytics, Internet Engineering, Health Economics, Entrepreneurship and Project Planning, IT for rural healthcare, Network Technologies, Software Systems

**UNIT I**

Health Informatics, Healthcare Management, Medical Language, Data Analytics, Internet Engineering, Health Economics, Entrepreneurship and Project Planning, IT for rural healthcare, Network Technologies, Software Systems.

**UNIT II**

Introduction to Informatics, Role of the health care worker, o Impact of informatics on professional practice, Components of hardware and software, Theoretical Issues for Health Care Informatics, Theories, Standardized languages, The Internet, Description, Structure, Portals, Security, Legal & ethical issues for health care professionals

**UNIT III & IV**

Informatics in Health Care Education, QSEN competencies, TIGER initiative, Online instruction, Social networking, Simulation, Student counselling, Informatics in Patient Care Settings, The EMR and the HER, HHS meaningful use criteria, Next generation nursing systems, Health data storage and exchange, Telemedicine, Clinical imaging, Automated staffing and workload systems, Quality assurance, Social, ethical and legal Issues

**UNIT V**

Informatics in Health Care Research, Data collection, Qualitative: data bases, Quantitative: lotus, spread sheets, Data analysis--qualitative and quantitative, Data Presentation, Social, ethical and legal Issues, Trends and directions for the future.

### Recommended Reading:

1. “Guide to Health Informatics” by COIERA, ISBN 9781444170498
2. “Public Health Informatics: Designing for change – a developing country perspective” by Sundeep Sahay and Sundararaman T, ISBN: 9780198758778
3. “Health Informatics: An Inter-professional Approach” by Nelson, eBook ISBN: 9780323402279, ISBN: 9780323402255, Paperback ISBN: 9780323402316
4. “Innovation with Information Technologies in Healthcare (Health Informatics)” by Lyle Berkowitz and Chris McCarthy, ISBN-13: 978-1447143260, ISBN-10: 1447143264
5. “Thesaurus of Health Informatics: 53 SHTI (Studies in Health Technology and Informatics)” by M E Sievert, ISBN-10: 0198758774, ISBN-13: 978-0198758778
6. “Aspects of Electronic Health Record Systems (Health Informatics)” by H Pardes and Harold P Lehmann, ISBN 10: 0387291547, ISBN 13: 978-0387291543

**Masters in Informatics**  
**Open Elective Courses**  
**ITOC01: IT Policy framework and Standards**

**Marks: 100**

**Duration: 60 Hrs**

### Course Objectives:

IT policies help organizations to properly articulate the organization’s desired behavior, mitigate risk and contribute to achieving the organization’s goals. This course describe the evolution of IT policies and standards. This course covers the advanced study of Information Security Policy and Governance at an organisational level. It will help understanding of standards and policies as well as international, national and local regulatory requirements governing organisational information technology systems. The unit will address relevant data protection legislation, industry best practices, risk management techniques and develop the necessary skills to evaluate and measure organisational compliance and to determine appropriate organisational strategy to best support the information security needs.

### Course Learning Outcomes:

- CO1: able to understanding of the tools for staff orientation.
- CO2: able to document proper delegation and define limits of authority and responsibility.
- CO3: able to serve as a documentation source for regulatory compliance.
- CO4: able to protect intellectual property and business continuity.
- CO5: able to improve clarity and momentum in projects and operations.

### Contents:

Evaluation, evidence and policy, Managing innovation and creativity, Managing strategic change, Project management, Research design OR Qualitative methods, Understanding public policy, Community empowerment and engagement, Governance and markets, IT and society,

International challenges, It and Gender, Sustainable development, Understanding policy. COBIT framework.

### **UNIT I**

Information Policies, Information Procedure, Information Standard, Information Guideline, Institutional IT Policies, Software Installation & Licensing Policy, Email Account Use Policy, Web Hosting Policy, User account and password policy, Data Retention Limits and Responsibilities, Reading website and web service agreements, Safety in BYOD setups, Understanding security dangers in public WiFi setups and staying protected, Understanding cyber bullying and its prevention, National IT policy and Cyber Law.

### **UNIT II**

Regulatory, Advisory, Informative, Organisational, System-Specific and Issue Specific Policies and Procedures. Incident Response, Auditing, Environmental/Physical and Administrative Factors, Procedure Implementation

### **UNIT III**

Understanding WiFi, OSI and TCP/IP Model, Common network attacks, DoS and DDOS, Man-in-the-middle attack, Phishing and Spoofing, Vulnerability Assessment and Penetration Testing Techniques and Frameworks, Vulnerability Management, Network Monitoring and Management.

### **Recommended Reading:**

1. Information Security Policies, Procedures, and Standards: A Practitioner's Reference by Douglas J. Landoll
2. Frameworks for ICT Policy: Government, Social and legal Issues by Esharenana E.Adomi. ISBN13: 9781616920128
3. Publications of Bureau of Indian Standards (BIS)
4. Publications of International Standards Organization (ISO)
5. Publications of Telecommunication Authority of India.
6. Rules and Policy documents from Ministry of Electronics & Information Technology (MeitY)

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Open Elective Courses**  
**ITOC02: Web & Mobile Application Development Frameworks**

**Marks: 100**

**Duration: 60 Hrs**

### **Course Objectives:**

This course will build skills in creating web applications and native mobile apps. It will help learn HTML/CSS and modern frameworks; PHP, JavaScript, Python, and other programming languages; and modern back-end technologies.

*Course Revision Ver. 1.1a.2018 (IIC, UDSC)*

**Course Learning Outcomes:**

CO1: Able to create interactive web experiences with JavaScript

CO2: Able to develop high quality web sites that, work seamlessly on mobile, tablet, and large screen browsers accessible

CO3: Able to develop a professional-quality web portfolio demonstrating your growth as a web developer and your knowledge of accessible web design.

CO4: Able to design and implement an application based on latest standards

CO5: Able to utilizes tools to create applications that is accessible to a wide audience, including those with visual, audial, physical, and cognitive impairments.

**Contents:**

**UNIT I**

Coding Techniques, OOP programing, Digital Project Management, Mobile App Development Android & iOS, data-driven applications. design principles, advanced programming, IT Security, protecting app data, Real-world problems, Foundation Networks, Enterprise system, cross-platform apps.

**UNIT II**

Introduction to Android platform: virtual machine, development tools, Java packages, emulators, services, Structure and lifecycle of an application for Android system, Graphical User Interface: preparing containers and components, management of component layout, event handling.

**UNIT III**

Processing of application resources, content providers, filesystem, Data persistence: backups, databases, Application security and permissions: security architecture, application signing, user identification, file access, declaration and verification of permissions

**UNIT IV**

Network communication and internet applications, Wi-Fi connections, Multimedia, 2D and 3D graphics processing, Simple game programming, Geographical location: use of GPS data.

**UNIT V**

Bluetooth communication: basics, permissions, Bluetooth device, discovery, device connectivity as a client, server creation, connection, management, Deployment of applications: localisation of applications, application, signing, version management, licences, preparing for distribution

**Recommended Reading:**

1. Swift Programming: The Big Nerd Ranch Guide, ISBN-10: 0134398017, ISBN-13: 978-0134398013
2. iOS Programming: The Big Nerd Ranch Guide (6th Edition), ISBN-10: 0134682335, ISBN-13: 978-0134682334
3. Android Programming: The Big Nerd Ranch Guide (3rd Edition), ISBN-10: 0134706056, ISBN-13: 978-0134706054

4. Mastering Xamarin UI Development by Steven F.Daniel
5. Xamarin Mobile Application Development: Cross-Platform C# and Xamarin.Forms Fundamentals by Hermes, Dan
6. Professional Android by Reto Meier, ISBN-13: 978-1118949528, ISBN-10: 1118949528.

**Masters of Science in Informatics – M.Sc. (Informatics)**  
**Open Elective Courses**  
**ITOC03: Cyber Security & Forensics**

**Marks: 100**

**Duration: 60 Hrs**

**Course Objectives:**

This course will provide the knowledge and skills of security and digital forensics expertise. The course will provide the principles of security and digital forensics, using specialist algorithms, software and equipment. The course will provide a solid foundation of the theoretical and practical aspects of the different dimensions of IT/cyber security, such as network security, software security, system security measures and models, information security, computer forensics, penetration testing and vulnerability assessment.

**Course Learning Outcomes:**

- CO1: Able to describes to how to identify, mitigate and prevent cyber security threats
- CO2: Able to respond to security incidents for government agencies and corporate organisations.
- CO3: Able to develop strong analytical and critical thinking skills
- CO4: Able to learn how to forensically examine digital evidence to solve computer crimes.
- CO5: Able to understand and explain risk and project management and knowledge of relevant standards and regulatory requirements.

**Contents:**

Cyber Forensics and Information Technology, Security Architectures and Systems Administration, Information Security Policy and Governance, Computer Security, Server Environments and Architectures.

**UNIT I & II**

Cyber Forensics and Information Technology, Security Architectures and Systems Administration, Information Security Policy and Governance, Computer Security, Server Environments and Architectures. Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management.

*Course Revision Ver. 1.1a.2018 (IIC, UDSC)*

## **UNIT II & IV**

Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security, Security Protocols: - security at the Application Layer- PGP and S/MIME, Security at Transport Layer- SSL and TLS, Security at Network Layer-IPSec. Introduction, Basic security for HTTP Applications and Services, Basic Security for SOAP Services, Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.

## **UNIT V**

Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Cryptography Management, Network Session Analysis, System Integrity Validation.

### **Recommended Reading:**

1. "Digital Forensics and Cyber Crime" by Joshua I James and Frank Breitinger, ISBN: 9788184204919, 8184204914, Edition: 1st, 2015
2. "Forensics Computer Investigator, Digital Forensics Analyst, Job Interview Bottom Line Practical Questions and Answers" by M Kumar
3. "Practical Forensic Imaging" by Bruce Nikkel, ISBN-10: 1593277938, ISBN-13: 978-1593277932
4. "Digital Forensic And Cyber Crime" by Mohammed Sajid, ISBN-10: 8184204914, ISBN-13: 978-8184204919.
5. "National Security and Counterintelligence in the Era of Cyber Espionage (Advances in Digital Crime, Forensics, and Cyber Terrorism)" by Eugenie de Silva, ISBN13: 9781466696617
6. "Handbook of Research on Civil Society and National Security in the Era of Cyber Warfare" by Metodi Hadji-Janev and Mitko Bogdanoski, ISBN13: 9781466687936.