Five Year Integrated Master of Science

(Computer Science)

Programme

Scheme and Syllabus (OBE based)

for Advanced level courses in Semester VII to X

Institute For Integrated Programmes & Research In Basic Sciences (IIRBS)

Mahatma Gandhi University

P. D. Hills P.O., Kottayam-686560

PREAMBLE

I am happy to present the detailed curricula and syllabi of the final four semesters (7-10) of the five year Integrated M.Sc. programmes of Institute for Integrated Programmes and Research in Basic Sciences (IIRBS) in the following five branches of Science.

1. Chemistry (CH)
2. Physics (PH)
3. Life Sciences (LS)
4. Computer Science(CS)
5. Environmental Science(ES)

It may be noted that, an expert committee was constituted *(vide UO 4460/ACA5/2019/MGU, dated 23.09.2019)* for framing the scheme, curriculum and syllabi for the five year Integrated Master of Science (Integrated M.Sc) programmes of Mahatma Gandhi University. Subsequently, the committee drafted the regulations, scheme, curriculum and syllabi of the five year integrated Master of science programmes of IIRBS and were approved *vide UO No. 4467/AC A 5/2020/MGU, dated 05.10.2020* w.e.f 2020 admission batch. However, this approval was involved the detailed scheme and syllabus for foundation level (first six semesters) courses and only scheme for the advanced level courses (in semesters 7-10). Now the expert committee has finalized the **detailed syllabi for advanced level courses in semesters 7-10** in accordance with the OBE format approved by the Mahatma Gandhi University and is presented hereafter. ***This syllabus shall be applicable w.e.f the 2023-24 academic year (for 2020 admission batch) onwards.***

The expert committee has framed the curriculum as per the Outcome Based Education (OBE) system. OBE is an educational approach that bases each part of the educational system with respect to the goals set for the students. OBE aims to equip the students (learners) with knowledge, competency orientations required for achieving their goals when they depart the institution. Further OBE empowers students to choose what they would like to study and how they would like to study it. The teaching methodologies and the evaluation system are also modified in par with the outcome based approach. The programme Specific Outcomes (PSOs) and the Course Outcomes (COs) are presented in the syllabus. The PSOs and the COs are well correlated in the syllabus of each course.

-Sd-
P.D. Hills — Dr. S. Anas
July, 2023 — (Convener, Expert committee)

Members of the Expert committee

1.	Dr. S. Anas, Honorary Director, IIRBS	Convener
2.	Dr. P. R. Biju, Professor, SPAP	Member
3.	Dr. K. B. Subila, Assistant Professor, SCS	Member
4.	Dr. Mahesh Mohan, Assistant Professor, SES	Member
5.	Dr. E.K. Radhakrishnan, Associate Professor, SBS	Member
6.	Dr. V. R. Bindu, Professor and Director, SoCS	Member
7.	Dr. Cyriac Joseph, Director, SPAP	Member
8.	Dr. Anitha C. Kumar, Director, SCS	Member
9.	Dr. K. R. Baiju, Director, SES	Member
10.	Dr. M. S. Jisha, Director, SoBS	Member

Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)

Institute for Integrated Programmes and Research in Basic Sciences (IIRBS**)**, was instituted directly under Mahatma Gandhi University in 2008 and was the first of this kind among the universities in Kerala. Subsequently, the Institute launched Five year Integrated Interdisciplinary Master of Science (Chemistry) programme in the year 2009. Over the years the institute has earned recognition as one of the best interdisciplinary institutions in terms of providing top-notch teaching learning environment and cutting edge instrumentation facilities. In 2020, IIRBS started innovative Five Year integrated interdisciplinary Master of Science programmes in five major disciplines of science (Physics, Chemistry, Life Sciences, Computer Science and Environmental Science). The major objective of the programmes is to integrate the conventional bachelors and masters programmes under a specified research oriented leaning environment by bringing together various science disciplines and thereby empower basic science education. These programmes are designed with an interdisciplinary approach to provide strong foundations for students to prepare for high quality research and expected to contribute to the talent pool of researchers and specialized technicians.

The regulations, scheme, curriculum and syllabi of the five year integrated Master of science programmes of IIRBS were approved *vide UO No. 4467/AC A 5/2020/MGU, dated 05.10.2020.* However, this approval was involved the detailed scheme and syllabus for foundation level (first six semesters) courses and only scheme for the advanced level courses (in semesters 7-10). Now the **detailed syllabi for advanced level courses in semesters 7-10** are prepared in accordance with the OBE format approved by the Mahatma Gandhi University.

Outcome based Education (OBE)

A high priority task in the context of education in India is improvement of quality of higher education for equipping young people with skills relevant for global and national standards and enhancing the opportunities for social mobility. Mahatma Gandhi University has initiated an Outcome Based Education (OBE) for enhancing employability of graduates through curriculum reforms based on a learning outcomes-based curriculum framework, upgrading academic resources and learning environment. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. The fundamental premise underlying the learning outcomes-based approach to curriculum development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes, expressed in terms of knowledge, understanding, skills, attitudes and values. Outcomes provide the basis for an effective interaction among the various stakeholders. It is the results-oriented thinking and is the opposite of input-based education where the emphasis is on the educational process.

The OBE Framework is a paradigm shift from traditional education system into OBE system where there is greater focus on programme and course outcomes. It guarantees that curriculum, teaching and learning strategies and assessment tools are continuously enhanced through a continuous improvement process. All decisions including those related to curriculum, delivery of instruction and assessment are based on the best way to achieve the predetermined outcomes. Traditionally, educators have measured learning in terms of standardized tests. In contrast, outcome-based education defines learning as what students can demonstrate that they know.

OBE is a comprehensive approach to organise and operate a curriculum that is focused onand defined by the successful demonstrations of learning sought from each learner. The term clearly means focusing and organising everything in an education system around “what

is essential for all learners to be able to do successfully at the end of their learning experiences". OBE is an approach to education in which decisions about the curriculum and instruction are driven by the exit learning outcomes that the students should display at the end of a programme or a course. By the end of educational experience, each student should have achieved the outcomes

Vision and Mission of Mahatma Gandhi University

Vision

"Mahatma Gandhi University envisions to excel in the field of higher education and cater to the scholastic and developmental needs of the individual, through continuous creation of critical knowledge base for the society's sustained and inclusive growth."

Mission

- To conduct and support undergraduate, postgraduate and research-level programmes of quality in different disciplines
- To foster teaching, research and extension activities for the creation of new knowledge for the development of society
- To help in the creation and development of manpower that would provide intellectual leadership to the community
- To provide skilled manpower to the professional, industrial and service sectors in the country so as to meet global demands
- To help promote the cultural heritage of the nation and preserve the environmental sustainability and quality of life
- To cater to the holistic development of the region through academic leadership

Vision and Mission of IIRBS

Our Vision:

Quality education in basic sciences by providing intellectual, instrumental as well as experimental support for pursuing excellence and thereby contribute to the talent pool of scholars.

Our Mission:

- To promote and disseminate high level knowledge in frontier areas of science
- To develop students as multidimensional personalities to create innovators for the service of human welfare
- To equip students to build up a scientific career and contribute towards the national development
- To inculcate among students human values with global competence

Programme Outcomes (PO) of Mahatma Gandhi University

PO 1: Critical Thinking and Analytical Reasoning

Capability to analyse, evaluate and interpret evidence, arguments, claims, beliefs on the basis of empirical evidence; reflect relevant implications to the reality; formulate logical arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; able to envisage the reflective thought to the implication on the society.

PO 2: Scientific Reasoning and Problem Solving

Ability to analyse, discuss, interpret and draw conclusions from quantitative/qualitative data and experimental evidences; and critically evaluate ideas, evidence and experiences

from an unprejudiced and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve problems and contextualise into research and apply one's learning to real life situations.

PO 3: Multidisciplinary/Interdisciplinary/Transdisciplinary Approach
Acquire interdisciplinary /multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary- approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills
Ability to reflect and express thoughts and ideas effectively in verbal and nonverbal way; Communicate with others using appropriate channel; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner and articulate in a specific context of communication.

PO 5: Leadership Skills
Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating a goal, building a team who can help achieve the goal, motivating and inspiring team members to engage with that goal, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO 6: Social Consciousness and Responsibility
Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability
Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity, managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning
Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work and living as a dignified person in the society.

PO 9: Networking and Collaboration
Acquire skills to be able to collaborate and network with scholars in an educational institution, professional organisations, research organisations and individuals in India and abroad.

PO 10: Lifelong Learning
Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of workplace through knowledge/skill development/reskilling.

Programme Specific Outcomes (PSO) for

Integrated M.Sc. (Computer Science)

Upon completion of the Integrated M.Sc. C
omputer science programme, the students will be able to accomplish the following outcomes

PSO	*Expected Outcome*
1	Acquire a strong foundation in Computer Science that emphasizes the scientific reasoning and problem-solving skills to analyze, design, and implement efficient algorithms and software solutions for complex computational problems.
2	Formulate solutions in interdisciplinary/multidisciplinary/transdisciplinary levels for problem solving in a collaborative environment by applying the knowledge gained from both computer science and complementary disciplines
3	Impart skills and abilities to effectively communicate technical concepts, maintain audience engagement and answer questions confidently.
4	Acquire skills to collaborate and network with scholars in various sectors and to develop leadership skills through team projects, and provide situations to coordinate and motivate team members towards successful outcomes.
5	Ability to evolve as a socially committed and responsible scientist/software professional meeting global demands.
6	Capable of demonstrating the ability to identify ethical issues related to software development and practicing good moral/ethical values in all phases of life.
7	Promote Research interest and aptitude in students and thereby enable them towards planning and execution of research in frontier areas of Computer science.
8	Stay up-to-date with the latest technologies/trends in the world and apply the lifelong learning to remain competitive and adaptable for a successful career in industry, entrepreneurship and higher studies.

SEMESTER VII to X (List of Courses Under Computer Science Major)					
SEMESTER VII					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC701CS	Operating Systems- Design Principles	3	1	0	3
IMSC702CS	Theoretical Computer Science	4	1	0	4
IMSC703CS	Wireless Communications	4	1	0	4
IMSC704CS	Advanced Java Programming	4	1	0	4
IMSC705CS	Java Programming Lab	0	2	6	2
IMSE706CS-n (n=1,2,3...)	1. Advanced Microprocessors 2. Advanced Computer Architecture	3	0	0	3
	Total	**20**	**6**	**6**	**20**
SEMESTER VIII					
IMSC801CS	Advanced Database Management Systems	2	1	2	3
IMSC802CS	Digital Image Processing	3	1	2	4
IMSC803CS	AI and Deep Learning	4	1	0	4
IMSC804CS	Data Mining	3	1	3	4
IMSC805CS	AI Lab	0	0	6	2
IMSE806CS-n (n=1,2,3...)	1. Cloud Computing 2. Distributed Systems	3	0	0	3
	Total	**15**	**4**	**13**	**20**
SEMESTER IX					
IMSC901CS	Data Analytics	2	1	2	3
IMSC902CS	Advanced Data Structures	2	1	2	3
IMSC903CS	Advanced Computer Security	2	1	2	3
IMSE904CS-n (n=1,2,3...)	1. Computer Vision 2. Speech and Natural Language Pro-cessing 3. Mobile Computing	3	0	0	3
IMSE905CS-n (n=1,2,3...)	1. Introduction to Block Chain 2. Internet of Things	2	0	0	2
IMSO906OC-n (n=1,2,3...)	Open Course	4	0	0	4
IMSC907CS	Minor Project	0	0	6	2
	Total	**15**	**3**	**12**	**20**
SEMESTER X					
IMSC100 PR	Major Research Project	0	0	0	16
IMSC100 VV	Comprehensive Viva-voce	0	0	0	4
	Total	**0**	**0**	**0**	**20**

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**Operating Systems - Design Principles**					
Type of course	**Core**	**Credit Value**	**3**			
Course code	**IMSC701CS**					
Name of Faculty						
Course Summary& Justification	The course provides a thorough discussion on the fundamentals ofoperating system design, relating these to contemporary design issues and current directions in the development of operating systems. The students will get acquainted with the design principles and implementation on issues of contemporary operating systems. The students will also get adeep understanding of various types of virtualization techniques, their advantages and disadvantages, in order to be able to apply them in a practical setting. For illustrating the concepts, four operating systems have been chosen as case studies.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18	-	18	90
Pre-requisite	Overview of Computer System and Operating System–Processes, Memory, Scheduling, Input/Output and Files					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Analyse the key design areas that have been instrumental in the development to modern operating systems.	U, An	1,2
2	Elucidate OS design issues raised by the introduction of Multiprocessor and multicore organization.	An	1,2,3
3	Compare and analyse the structure, functional elements and features of Windows, Traditional and ModernUNIX, Linux and Android operating systems.	An	1,2
4	Critically examine the requirements for process control by the OS and analyse the issues involved in theExecution of OS code.	A, An	1,2,3
5	Develop programs implementing multithreading.	U, A	1,2
6	Compare and analyse the process and thread management, concurrency and synchronization methods and the virtual memory management mechanisms in UNIX, Linux, Solaris, Windows and Android operating systems.	R, An	2,3

7	Identify and analyse the key design issues in multiprocessor thread scheduling and some of the key approaches to scheduling and understand the requirements imposed by real-time scheduling.	An	2, 8
8	Analyse and compare the scheduling methods used in Linux, UNIX SVR4, and Windows10.	U, An	1,2
9	Critically examine some of the key issues in the design of OS support for I/O and describe the I/O mechanisms in UNIX, Linux, and Windows.	U, An	5
10	Define and discuss virtual machines and virtualization and conceptualize and implement the various approaches to virtualization.	U, A, An	7 ,8
11	Conceptualize, formulate and design a sample operating system and document, present and demonstrate concepts in a very clear and effective way with the aid of appropriate tools.	U, A, An, C,E	8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Overview of Operating Systems** Introduction - Characteristics of Modern Operating Systems, Symmetric Multiprocessing and Micro-kernels, Virtual Machines, OS Design Considerations for Multiprocessor and Multicore, Windows Overview, Modern UNIX Systems, Linux, Android.	15	1,2,3
2	**Processes and Threads** Processes and Threads - Process Description and Control, Security issues, UNIX SVR4 Process Management, Threads, Windows Process and Thread Management, Solaris Thread and SMP Management, Linux Process and Thread Management, Android Process and Thread Management, Unix Concurrency Mechanisms, Linux Kernel Concurrency Mechanisms, Solaris Thread Synchronization Primitives, Windows Concurrency Mechanisms, Android Inter-process Communication.	20	4,5,6,11
3	**Advanced Memory Management** NIX and Solaris Memory Management, Linux Memory Management, Windows Memory Management, Android Memory Management. Scheduling - Traditional UNIX Scheduling, Multiprocessor and Multicore Scheduling, Realtime Scheduling, Linux Scheduling, UNIX SVR4 Scheduling, Windows Scheduling.	13	7,8,11
4	**Advanced File Management** Input / Output and Files - UNIX SVR4 I/O, Linux I/O, Windows I/O, Unix File Management, Linux Virtual File Systems, Windows File System, Android File Management	12	9,11
5	**Introduction to Virtualization** Virtualization Concepts: Virtual machines; Process Virtual Machines, System Virtual Machines, Multiprocessor Virtualization, Applications for VM Technology Approaches to Virtualization: Hypervisors, Containers, Processor Issue, Memory Management, I/O Management, VMware ESXi, Microsoft Hyper-V and Xen Variants, Java VM.	12	10,11

References

1. *William Stallings, Operating Systems: Internals and Design Principles, 9th Ed, Prentice-Hall.*
2. *Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts, 8th Ed, John Wiley.*
3. *James E. Smith, Ravi Nair, Virtual Machines-Versatile Platforms for Systems and Processes, Morgan Kaufmann Publishers.*
4. *Matthew Portnoy, Virtualization- Essentials, John Wiley & Sons, Inc.*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** • Continuous Internal Assessment (40%) ◦ Internal Tests ◦ Assignments ◦ Seminar Presentation ◦ Review Report • End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M. Sc. (Computer Science)**		
Course Name	**Theoretical Computer Science**		
Type of course	**Core**	**Credit Value**	**4**
Course code	**IMSC702CS**		
Name of Faculty			
Course Summary& Justification	The course provides an insight into the foundations of automata theory through a set of abstract machines that serve as models for computation- finite automata, pushdown automata, and Turing machines and examines the relationship between these automata and formal languages. This has applications in circuit design, compiler design, search algorithms, cryptography and optimization problems in manufacturing, business, and management.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	72	18	-	10	100

Pre-requisite	Discrete Mathematics, Data Structures and Algorithms

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Formalize the notion of computation using abstract computing devices called automata	An, A	1
2	Understand the hierarchy of classes of automata: finite automata, pushdown automata, linear bounded automata, and Turing machines	U, An	2
3	Formalize the notion of problems via formal languages and classify them into regular, context-free, context sensitive and unrestricted languages	A, An, E	1,2
4	Design finite state automata, regular grammar and regular expression for regular languages	A, An, C	2, 4
5	Design push-down automata and context-free grammar representations for context-free languages.	A, An, C	1, 7
6	Design Turing Machines for accepting recursively enumerable languages,	A, An, C	1, 6
7	Understand the concepts of undecidability, intractable problems, DNA computing and membrane computing	U, E	2

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Finite Automata** The central concept of Automata Theory, Introduction to Finite Automata, Deterministic Finite Automata, Nondeterministic Finite Automata, Finite Automata with ϵ-Transitions	14	1
2	**Regular Expressions and Languages** Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions. Properties of Regular Languages: The Pumping Lemma for Regular Languages, Closure properties of Regular Languages, Decision Properties of Regular Languages, Equivalence and Minimization of Automata.	24	2
3	**Context-Free Grammars and Languages** Context-Free Grammars, Parse Trees, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages.	20	2,3,4
4	**Properties of Context Free Languages** Normal Forms for Context Free Grammars, The Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages, Decision Properties of Context-Free Languages.	18	2,3,4,5
5	**Turing Machines** Turing Machines: The Turing Machine, Programming Techniques for Turing Machines, Turing Machines and Computers. Introduction to: Undecidability, Intractable Problems, DNA Computing, Membrane Computing.	14	2,3,6,7

References

1. *John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Introduction to Automata Theory, Languages and Computation, Pearson, 3rd Edition.*
2. *Peter Linz, An Introduction to Formal Language and Automata, Jones and Bartlett Publishers, 6th Edition.*
3. *Kamala Krithivasan, Rama R., Introduction to Formal Languages, Automata Theory and Computation, Pearson.*
4. *John C. Martin, Introduction to the Languages and the Theory of Computation, Tata McGrawHill, 3rd Edition.*
5. *M.Sipser, Introduction to the Theory of Computation, Singapore: Brooks/Cole, Thomson Learning, 3rd Edition*
6.

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%), Internal Tests, Assignments, Seminar Presentation, Review Report B. End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**Wireless Communications**					
Type of course	**Core**	**Credit Value**	**4**			
Course code	**IMSC703CS**					
Name of Faculty						
Course Summary& Justification	Telecommunication involves transmission of information without wires, cables or any other electrical conductors within a shorter distance or across the globe. This course introduces basics of cellular concept, generations of Cellular communication, adhoc/sensor networks, Routing protocols used and Quality of Service					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	72	18	-	10	100
Pre-requisite	Basics of Data Communication					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand fundamentals of Wireless communication System	R, U	1, 2
2	Elucidate generation of Cellular Networks	E, U	1, 2, 3
3	Analyze various types of Channel Assignment Strategies	An	2, 3
4	Analyze adhoc/sensor networks	U	2, 4
5	Illustrate issues in adhoc wireless networks	A	6
6	Examine MAC protocols for adhoc wireless networks	A	3
7	Investigate the role of Routing Protocols for sensor network, location discovery, quality and other issues	E	8
8	Apply Quality of Service in energy management	A	4,6

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Evolution of mobile communications** Mobile Radio System around the world, Types of Wireless communication System, Comparison of Common wireless system, Trends in Cellular radio and personal communication. Second generation Cellular Networks, Third Generation (3G), 4G and 5G networks. Wireless Local Loop (WLL), Wireless Local Area networks (WLAN), Bluetooth and Personal Area Networks.	16	1,2
2	**The Cellular Concept** Hexagonal geometry cell and concept of frequency reuse, Channel Assignment Strategies, Distance to frequency reuse ratio, Handoff Strategies, Umbrella Cell Concept, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular System-cell splitting, Cell sectorization, Repeaters, Micro cell zone concept	18	3
3	**Introduction to adhoc/sensor networks** Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering. MAC Protocols: Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality and other issues.	20	4,5,6,7
4	**Routing Protocols** Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.	18	8
5	**QoS and Energy Management** Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power and system power management schemes.	18	8

References

1. *Theodore S. Rappaport, Wireless Communication, Prentice Hall.*
2. *Vijay Garg, Wireless Communications and Networking, Elsevier.*
3. *Feng Zhao and Leonides Guibas, Wireless sensor networks, Elsevier publication.*
4. *Jochen Schiller, Mobile Communications, Pearson Education, 2nd Edition.*
5. *William Stallings, Wireless Communications and Networks, Pearson Education.*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests, Assignments, Seminar Presentation, Review Report B. End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**Advanced Java Programming**					
Type of course	**Core**	**Credit Value**	**4**			
Course code	**IMSC704CS**					
Name of Faculty						
Course Summary& Justification	This course helps students to become familiar with the advanced features of Java language. This includes developing Distributed Application using Remote Method Invocation. They can be able to develop Web Applications using Servlets / JSP. Reusable components can be developed using JavaBeans. They get acquainted with Struts and Hibernate.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	72	18	-	10	100
Pre-requisite	Basics of Java programming					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Create Distributed Application using Remote Method Invocation	C, S	1, 2
2	Understand basic servlet architecture	U, R	3, 4
3	Implement form processing and data base connectivity using Java Servlets	C, U, S	2, 3
4	Understand basics of scripting and develop applications using Java Server Pages	U, C	1, 2, 3,8
5	Create reusable components using EJB	C, S	7
6	Create web applications using Struts and Hibernate	C, A, S	1, 2, 3

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Distributed Application using Remote Method Invocation** Introduction to RMI, Defining the Remote Interface, Implementing the Remote Interface, Defining the Client, Compile and Execute the Server and the Client	14	1
2	**Java Servlets** Servlet Overview, Basic Servlet Architecture, Servlet Form Processing, Session Management, Database Management Using Servlets.	16	2, 3
3	**Java Server Pages** Basic JSP Scripting, JSP Architecture, Using JSP Scripting Elements, Implicit Objects, JSP Directives, Using Database with JSP, Java beans and their Application in JSP.	20	4
4	**Introduction to Distributed Applications and Components** Introduction to J2EE architecture, Enterprise Java Beans (EJB) - Application Servers-Types of Bean Session Bean Entity Bean, Message Driven Bean.	20	5
5	**Struts and Hibernate** Introduction to Struts, Overview of MVC Design, Struts Components, Configuration files- Introduction to Hibernate, Hibernate Application, Hibernate Object Life Cycle.	20	6

References

1. *Budi Kurniawan , Sams, Java for the Web with Servlets, JSP, and EJB: A Developer's Guide to Scalable J2EE Solutions, 2002.*
2. *Karl Avedal, Professional JSP, Wrox Press, 2nd Edition.*
3. *James Holmes, The Complete Reference to Struts, Tata McGraw-Hill, Second Edition.*
4. *Jeff Linwood, Dave Minter, Beginning to Hibernate, Second Edition.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Computer Science)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**Java Programming Lab**					
Type of course	**Core**	**Credit Value**	**2**			
Course code	**IMSC705CS**					
Name of Faculty						
Course Summary& Justification	The course provides an insight into advanced Java programming for web-based applications. The students will be acquainted with the design and implementation of Distributed Application using Remote Method Invocation, servlets, JSP scripting, Java Beans, Struts and Hibernate.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independant Learning etc..	-	36	72	12	120
Pre-requisite						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Create Distributed Application using Remote Method Invocation	C, U	1, 2
2	Familiarise with web servers	U, C, S	1, 2
3	Familiarise form processing and data base connectivity using Java Servlets	C, S	3
4	Understand basics of scripting and develop applications using Java Server Pages	U, C, S	1, 2, 3
5	Create reusable components using EJB	C, S, A	1, 2, 3
6	Familiarise with Struts and Hibernate	C, S, A	5

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	Distributed applications using Remote Method Invocation (RMI)	15	1
2	Overview of different web server	16	2
3	Form processing using servlets	17	2

4	Connect to Database using servlets	15	3
5	Create JSP scripts and implement data base connectivity	15	4
6	Design Javabeans and applications	15	5
7	Create Java applications using Struts and Hibernate	15	6

References

1. *Budi Kurniawan, Sams, Java for the Web with Servlets, JSP, and EJB: A Developer's Guide to Scalable J2EE Solutions, 2002.*
2. *Karl Avedal, Professional JSP, Wrox Press, 2nd Edition.*
3. *James Holmes, The Complete Reference to Struts, Tata McGraw-Hill, Second Edition.*
4. *Jeff Linwood, Dave Minter, Beginning to Hibernate, Second Edition.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Technical skills evaluation - Correctness of programs • Internal Tests – Minimum two (Practical) • Assignments - Lab Records, Practical and Viva • Case study

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Computer Science)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**Advanced Microprocessors**					
Type of course	**Elective**	**Credit Value**	**3**			
Course code	**IMSE706CS-1**					
Name of Faculty						
Course Summary& Justification	The course provides an insight into understanding of architecture and operation of modern microprocessors, enabling to bridge the gap between hardware and software, fostering expertise in embedded systems design, digital logic, and signal processing. This knowledge empowers students to pursue diverse career opportunities, innovate in emerging technologies, and contribute to advancements in fields such as artificial intelligence, robotics, and more, making it a cornerstone for technological progress and innovation in today's interconnected world.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	-	-	46	100
Pre-requisite						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand and analyze advanced microprocessor architectures, components, and functionalities, enabling effective analysis and design of complex systems.	R, U, An	1,2
2	Apply assembly language programming, to harness the full potential of microprocessors and optimize code execution.	A, An	1,2,3,4
3	Understand and design multiprocessor-based systems, its software aspects and programming	A, S	1,2
4	Distinguish and analyse the properties of microprocessors and microcontrollers, and illustrate the interfacing of peripherals.	A, An, S	1,2,3
5	Design different interfacing applications using microcontrollers and peripherals.	An, S	1,2,3,4

6	Understand and analyse the features of bus standards	U, An	2,3

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Advanced Microprocessor System** Introduction to Pentium Processors, features of 80586 (Pentium)Processor, Concepts of Computer Architecture and System Architecture, Branch Prediction, Enhanced Instruction Set of Pentium.	8	1,2
2	**Introduction to MMX** MMX, Intel MMX Architecture MMX Data Types Wraparound and Saturation Arithmetic, MMX Instruction Set. Salient Points about Multimedia Application Programming, Journey to Pentium-Pro and Pentium-II and Pentium III etc.	12	1,2
3	**Multi-microprocessor Systems** Interconnection Topologies, Software aspects of Multi-microprocessor Systems, Numeric Processor 8087, I/O Processor 8089, Bus Arbitration and Control, Tightly Coupled and Loosely Coupled Systems.	12	3
4	**Microcontrollers and Peripherals** Intel's Family of 8-bit Microcontrollers, Architecture of 8051, Signal and description of 8051, Register set of 8051, Addressing Modes of 8051,8051 instruction set. Peripheral ICs: Functional block diagram, features, various operating modes of IC 8255.	14	4,5
5	**Bus Standards** Bus standards: Need for Bus standards. Features of RS232, Parallel Centronics Bus, SATA Bus, I2 C Bus. USB-Structure, operation and features.	8	6

References

1. *Advanced Microprocessor and Peripherals M Bhurchandi, A K Ray, Tata Mc Graw Hill Education Private Limited, Third Edition.*
2. *Douglas V Hall, "Microprocessor & Interfacing: Programming and Hardware", Tata McGraw Hill, 2nd Edition.*
3. *Barry B. Brey, "The Intel Microprocessors-Architecture, Programming, and Interfacing", Pearson Education India. Eighth Edition.*
4. *Yn - cheng Liu and Gibson, G.A., "Microcomputer Systems: The 8086 / 8088Family Architecture, Programming and Design", Prentice Hall of India, 2nd Edition.*
5. *Triebel, walter, Avatar singh," The 8088 and 8086 microprocessors: programming, interfacing, software, hardware, and applications: including the 80286, 80386, 80486, and Pentium processors", Prentice Hall, Fourth edition.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment**

	• Continuous Internal Assessment (40%) ◦ Internal Tests ◦ Assignments ◦ Seminar Presentation ◦ Review Report • End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Computer Science)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**Advanced Computer Architecture**					
Type of course	**Elective**	**Credit Value**	**3**			
Course code	**IMSE706CS-2**					
Name of Faculty						
Course Summary& Justification	The course covers the architectures of single and multi-core microprocessors, parallel computer architecture and various parallel programming models and features. The course further discusses parallel programming with OpenMP and MPI. The students after studying this course will be able to know the architecture and working of Pentium microprocessor, multicore microprocessors and GPUs. The students will be equipped with various technical and programming skills.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	-	-	46	100
Pre-requisite	Basics of Computer Organisation and Architecture					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the difference in the features of single core and multicore processors.	U	2
2	Conceptualize the specific features of a parallel computer through Flynn's Taxonomy	U, An	1,2
3	Illustrate the application of various architectures of Intel processors.	U, R, An	2,3
4	Develop and test programs in OpenMP and MPI	A, An, C	2, 5, 8
5	Demonstrate the interconnection networks possible within a multicore architecture	R, U, E	1,2,3
6	Evaluate the performance of processors based on memory hierarchy, cache performance and cache designing.	A, An, E	2, 3, 7
7	Research, identify and create alternate solutions for the basic Cache Coherence Issues	An, A, C	2, 5, 8
8	Demo the application of the features of OpenCL/CUDA to solve problems that needs massively Parallel data handling	A, C, S	5, 8

	operations with GPU processors.		

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Single Core to Multi-core Microprocessors** Introduction to Pentium IV Microprocessors, Architecture, Special Features, Registers, Addressing Modes, Memory Management, New Pentium Instructions. An Introduction to Multicore Processors, Single Core Vs Multicore Processors, Architecture and PIN Descriptions of Intel Core 2 Processors.	10	1,2
2	**Parallel Computer Architecture** Flynn's Taxonomy of Parallel Architectures, Classes of MIMD Parallel Computers, Parallel Programming Models, Levels of Parallelism, Simultaneous Multithreading (SIMT) Architecture, Energy Consumption of Processors, Architecture of Multicore Processors, Case Study: Architecture of the Intel Core i7, Interconnection Networks, Parallel Computational Complexity, Laws and Theorems of Parallel Computation.	10	3,5
3	**Parallel Programming** Shared Memory Programming Model, Multithreaded Programs, Parallelization of Loops, Parallel Tasks, MPI Processes and Messaging, Distributed Memory Computers, Message Passing Interface, Basic MPI Operations, Process-to-Process Communication, Collective MPI Communication, Sources of Deadlocks.	14	4
4	**Memory Hierarchy Organization** Basic Architectures of a Cache, Cache Performance, Prefetching, Cache Designing, Multicore Architecture, Physical Cache Organization, Logical Cache Organization, Case Studies. Introduction to Shared Memory Multiprocessors, Basic Cache Coherence Issues, Hardware Support for Synchronization, Memory Consistency Models, Advanced Cache Coherence Issues.	12	6,7
5	**Graphic Processors** Anatomy of a GPU, Programmer's View of OpenCL, Programming in OpenCL/CUDA	8	8

References

1. *Roman Trobec, Boštjan Slivnik Patricio Bulić, Borut Robič, Introduction to Parallel Computing From Algorithms to Programming on State-of-the-Art Platforms, Springer Nature Switzerland AG.*
2. *Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press.*
3. *Thomas Rauber, Gudula Runger, Parallel Programming for Multicore and Cluster Systems, Second Edition, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-37800-3.*
4. *Aaftab Munshi, Benedict R. Gaster, Timothy G. Mattson, James Fung, Dan Ginsburg, OpenCL Programming Guide, Addison-Wesley, Pearson Education Inc.*
5. *David W. Walker, Parallel Computing, Encyclopedia of Physical Science and Technology (Third Edition).*
6. *A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals- Architectures, 3e, McGrawHill Education (India)Pvt. Ltd.*

7. *Berry.B.Brey, The Intel Microprocessors 8086/8088 /80186/80188, 80286, 80386,80486 PENTIUM, PENTIUM Pro, PII, PIII & IV Architecture, Programming & Interfacing, Pearson Education..*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** • Continuous Internal Assessment (40%) ◦ Internal Tests ◦ Assignments ◦ Seminar Presentation ◦ Review Report • End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M. Sc. (Computer Science)**		
Course Name	**Advanced Database Management Systems**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC801CS**		
Name of Faculty			
Course Summary& Justification	This course is designed to provide students with an in-depth understanding of advanced concepts and techniques in designing, implementing, and managing complex database systems. Building upon the foundational knowledge of basic database principles, this course equips students with the skills needed to handle the challenges posed by modern data-intensive applications. Through a combination of theoretical concepts, practical exercises, and real-world case studies, students will gain a comprehensive understanding of advanced database topics.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	18	36	10	100

Pre-requisite	Overview of Database Management System

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Demonstrate a solid understanding of fundamental database concepts, including data models, relational algebra, and the importance of data-base design.	U, An	1, 2
2	Construct clear and well-structured entity-relationship diagrams (ERDs) to visualize database structures and relationships.	C, An	1, 2, 3
3	Design schemas that support efficient querying, taking into account the types of queries the database is expected to handle.	A, An	1, 2, 3
4	Design databases with recovery considerations in mind, including log-based approaches, to ensure data integrity in the face of failures.	C, A, An	4, 5
5	Analyze the performance implications of centralized and distributed database systems, considering factors like network latency and data transfer costs.	U, A	6, 7
6	Identify scenarios where object-oriented databases are advantageous over traditional relational databases.	R, U, An	1, 2, 7
7	Demonstrate a comprehensive understanding of various types of da-	A, An	8

	tabases, their characteristics, and typical use cases.		
8	Analyze application requirements to determine the most suitable database type.	An, A	

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Relational Database Design** Features of good database design, Enhanced ER tools, Subclasses, Super class, and Inheritance, Specialization and Generalization, Constraints and Characteristics of Specialization and Generalization, Converting EER diagram to tables, Functional Dependency Theory and Normalization	18	1,2,3
2	**Transaction Management and Recovery** Advanced feature of Transactions, Enhanced Lock Based and timestamp-based Protocols, Deadlock Handling, Recovery and Atomicity, Recovery with Concurrent Transaction, Advanced Recovery Techniques, Database Security and Authorization	20	4
3	**Centralized versus non centralized Databases** Homogeneous and Heterogeneous DDBMS and their Comparison, Functions and Architecture, Distributed database design, query processing in DDBMS, Distributed concurrency management, deadlock management, Distributed Commit Protocols: 2 PC and 3 PC, Concepts of replication servers.	24	5
4	**Need of Object-oriented databases** Complex Data types, Structured Types and Inheritance in SQL, Table Inheritance, Data types (arrays, multiset) and structure in Object oriented databases using SQL, Object- Identity and Reference Types in SQL, ODL and OQL, Object- Oriented versus Object- Relational databases.	18	6
5	**Types of databases** Multimedia database, NoSQL database, Graph database, Columnar database, Time series database.	10	7,8

References

1. *Ramez Elmasri, Shamkanth B Navathe, Fundamentals of Database Systems, Pearson 6 th Edition.*
2. *Abraham Silberschatz, Henry F. Korth, S. Sudarshan: Database System Concepts, 6 th Edition, McGraw Hill.*
3. *Thomas M. Connolly, Carolyn E. Begg, Database Systems, Addison Wesley.*
4. *C.S.R. Prabhu, Object-Oriented Database Systems: Approaches and Architectures Prentice-Hall of India Pvt. Limited.*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work

Assessment Types	**Mode of Assessment**
	• Continuous Internal Assessment (40%)
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**Digital Image Processing**					
Type of course	**Core**	**Credit Value**	**4**			
Course code	**IMSC802CS**					
Name of Faculty						
Course Summary& Justification	The course provides a thorough discussion on the fundamentals of digital image processing, relating these to contemporary technologies and applications. The students will get a deep understanding of digital image processing operations and can implement these operations practically through programming. They will also be made capable of applying this knowledge for practical applications.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18	36	12	120
Pre-requisite	Overview of Computer System and basic mathematics.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Define the elements of image processing and differentiate color image models in imagerepresentation.	U, An	1,2,10
2	Compare and analyse various spatial domainand frequency domain image transformations and filtering techniques.	An	1,2,3
3	Analyse and compare various imageenhancement Techniques.	An	1,2
4	Illustrate histogram processing on an image.	A, An	1,2
5	Analyse and compare various imagerestoration techniques.	An	1,2,3
6	Illustrate different morphological operations on an image.	A, An	1,2,3
7	Analyse and compare various image segmentation techniques.	An	1,2,3
8	Illustrate segmentation of an image.	A, An	2,3
9	Develop programs implementing the different image processing operations on sample images.	U, A	1,2, 7, 8
10	Discuss image recognition techniques.	U, An	1,2
11	Analyse and compare the methods for image compression.	An	1,2,3

12	Discuss, analyse and compare the latest technologies and issues in Digital Image Processing.	U, An, A, C, E	1,2,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Elements of digital image processing systems** Elements of visual perception, psycho visual model, brightness, contrast, hue, saturation, Mach band effect, Color image fundamentals - RGB, HSI models, Image acquisition and sampling, Quantization, Image file formats, Two- dimensional convolution, correlation, and frequency responses.	18	1
2	**Image Transforms** 1D DFT, 2D transforms – DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD, Radon and Wavelet Transform.	20	2,12
3	**Image Enhancement and Restoration** Histogram modification and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contra harmonic filters, Homomorphic filtering, Color image enhancement. Image Restoration – degradation model, Unconstrained and Constrained restoration, Inverse filtering, Wiener filtering, Geometric transformations – spatial transformations, Gray-Level interpolation.	25	2,3,4,5, 12
4	**Image Segmentation and Recognition** Edge detection. Image segmentation by region growing, region splitting and merging, edge linking, Morphological operators: dilation, erosion, opening, and closing. Image Recognition – Patterns and pattern classes, matching by minimum distance classifier, Statistical Classifier. Matching by correlation, Neural network application for image recognition.	25	6,7,8,10 ,12
5	**Image Compression** Need for image compression, Huffman, Run Length Encoding, Arithmetic coding, Vector Quantization, Block Truncation Coding. Transform Coding – DCT and Wavelet. Image compression standards.	20	9,11,12

References

1. *Rafael C. Gonzalez, Richard E. Woods, 'Digital Image Processing', Pearson Education,Inc.*
2. *Scott E Umbaugh, 'Digital Image Processing and Analysis', CRC Press.*
3. *Anil K.Jain, 'Fundamentals of Digital Image Processing', Prentice Hall of India.*
4. *David Salomon: Data Compression – The Complete Reference, Springer Verlag New YorkInc.*
5. *Rafael C. Gonzalez, Richard E.Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education.*
6. *William K. Pratt, 'Digital Image Processing', John Wiley, NewYork.*
7. *Milan Sonka, Vaclav Hlavac, Roger Boyle, 'Image Processing, Analysis, and Machine Vision', Brooks/Cole, Vikas Publishing House.*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work

Assessment Types	**Mode of Assessment**
	• Continuous Internal Assessment (40%)
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Computer Science)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**AI and Deep Learning**					
Type of course	**Core**	**Credit Value**	**4**			
Course code	**IMSC803CS**					
Name of Faculty						
Course Summary& Justification	This course provides an in-depth introduction to the fundamental concepts, techniques, and applications of Artificial Intelligence and Deep Learning. Students will gain theoretical knowledge and hands-on experience in building AI models using deep learning techniques.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	72	18	-	10	100
Pre-requisite	Basics of Linear Algebra					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Define and explain key concepts in Artificial Intelligence.	R, U	1, 2
2	Apply search algorithms to various scenarios and represent knowledge using logic and effectively reason with it.	A, An	1, 2, 3
3	Describe the architecture and functioning of a neural network.	E, An	1, 4
4	Apply gradient-descent, regularization and optimization techniques to train deep neural networks,	A, E	1,2, 3
5	Construct and train convolutional and recurrent neural networks.	C, A	1, 3,7
6	Create GANs and Transfer learning-based applications.	C, E	1, 2, 4
7	Apply the concept of Auto encoders and Long Short-Term Memory.	C, A	1, 2, 4
8	Investigate Advanced Deep Learning Models and applications.	A, An, E	1, 2, 8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Overview of Artificial Intelligence** Problem definition as a State Space Search, Production System, Control Strategies, Uninformed and Informed Search Algorithm, Constraint Satisfaction Problems, Knowledge Representation.	12	1,2
2	**Artificial Neural Networks** Artificial Neural Networks: Introduction, Perceptron, Activation Functions, Sigmoid, ReLU, Hyperbolic, SoftMax functions, McCulloch Pitts Neuron.	14	3
3	**Gradient Descent and Backpropagation** Feedforward Neural Networks, Backpropagation, Gradient Descent (GD), Stochastic Gradient Descent, Momentum Based GD, Nesterov Accelerated GD, Backpropagation, Some problems in ANN, Regularization and Optimization techniques.	22	4
4	**Convolutional Neural Networks** Convolution Operation, Pooling Operation, Convolution Variants, Advanced CNN architectures, Transfer Learning, GANs.	20	5, 6
5	**Recurrent Neural Networks (RNN)** Basics, Training RNNs, Bidirectional RNNs, Encoder-Decoder Architecture, Gradient Explosion and Vanishing, Gradient Clipping, Autoencoders, Long Short-Term Memory. Advanced Deep Learning Models and Applications.	22	7, 8

References

1. *S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2015.*
2. *Elaine Rich and Kelvin Knight, Artificial Intelligence, 3rd edition, Tata McGraw Hill.*
3. *Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press.*
4. *Sandro Skansi, Introduction to Deep Learning, From Logical Calculus to Artificial Intelligence, Springer.*
5. *Umberto Michelucci, Advanced Applied Deep Learning, Apress.*
6. *Yegnanarayana B, Artificial Neural Networks, Prentice-Hall India Pvt. Ltd.*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work

Assessment Types	**Mode of Assessment**
	• Continuous Internal Assessment (40%)
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Computer Science)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M. Sc. (Computer Science)**					
Course Name	**Data Mining**					
Type of course	**Core**	**Credit Value**	**4**			
Course code	**IMSC804CS**					
Name of Faculty						
Course Summary& Justification	This course provides information on various data mining methodologies and techniques and is deeply related to scientific research areas. The content includes background of datamining, data warehouse schemes and operations on them, pre-processing techniques, Frequent patterns identification, information retrieval, classification, clustering, association mining, advanced techniques for classification etc.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18	54	-	126
Pre-requisite	Understanding in Database Management and Statistics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the various functionalities or principles of data mining.	U	2
2	Design an efficient data warehouse model, given a data mining problem.	A, An, C	1, 2
3	Illustrate the application of various data mining functionalities such as Association rule Mining, Classification of objects, Clustering, Information retrieval, and Outlier detection.	U, R, An	2, 3
4	Implement the algorithms of the various data mining function-alities and analyse the performance of the algorithms to select the best.	A, An, C	2, 5, 8
5	Demonstrate the benefits of various visualisation tools.	R, U, E	1, 2, 3, 5
6	Evaluate the performance of the multiple algorithms for a specific functionality to select the best.	A, An, E	1, 2, 3
7	Research, identify and create alternate innovative and better than existing, solutions for a data mining problem.	An, A, C	2, 3, 7

8	Analyse a given problem and identify which data mining functionality is the most suitable one.	An, A	1,2,5.
9	Compare the various model evaluation techniques and identify the most suitable to evaluate a new classifier.	A, C, S	3, 4, 5
10	Prepare a report and do a presentation on the comparative study of the applications of Data Mining in the domains: WWW, Spatial, Text, Image, and temporal data.	U, R, An	2, 3, 5, 8
11	Develop new clustering/classifier/outlier detection algorithms for any application, document, present and demonstrate the working of that method.	An, E, C	2, 5, 8
12	Acquire knowledge and skills through self-paced and self-directed learning and adapt to changing trends through knowledge/skill updation/reskilling.	U, An, A,C, E	7, 8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction to Data Mining** Data Mining Functionalities, Classification of Data Mining Systems, Major Issues in Data Mining, Basic Concepts of Data Warehouse, Multitiered Data Warehouse Architecture, Data Warehouse Models, Data Warehouse Modeling, Data Cube, a Multidimensional Data Model, Schemas for Multidimensional Data Models, Stars, Snowflakes, Fact Constellation Technology. Typical OLAP Operations.	23	1
2	**Data Objects and Attribute Types** Basic Statistical Description of Data, Visualisation Techniques, Pixel Oriented, Geometric Projection, Icon-based, Measuring Data Similarity and Dissimilarity, Data Matrix, Dissimilarity Matrix, Measures for Nominal Attributes, Binary Attributes, Numeric Data, Ordinal Attributes, Cosine Similarity, Need of Preprocessing the Data, Major Tasks, Data Cleaning, Data Integration, Data Reduction, Overview of Data Reduction Strategies, Principal Component Analysis, Attribute Subset Selection, Histograms, Clustering, Transformation, Overview of Transformation Strategies, Normalisation, Discretization by Histogram analysis, Cluster, Correlation Analysis	28	2, 3, 4,5
3	**Mining Frequent Patterns** Associations and Correlations: Basic Concepts, Frequent Itemset Mining Methods, Apriori Algorithm, Mining Frequent Item sets using Vertical Data Formats, Generating Association Rules, Strong Rules and Weak Rules.	27	6, 7, 8
4	**Introduction to Classification** Classification by Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Naïve Bayesian Classification, Classification by Back propagation, Lazy Learners, k-Nearest Neighbor Classifiers, An Overview of Other Classification Methods, Genetic, Fuzzy Sets, Model Evaluation and Selection, Haldout Method, Cross Validation, Boot Strap	25	9, 10

5	**Introduction to Cluster Analysis** An Overview of Major Clustering Methods, Partitioning Methods, Hierarchical Methods, Density-BasedMethods, Probabilistic Model-Based Methods, Expectation-Maximisation Algorithm, OutlierDetection, Outlier Detection Methods, Introduction to Spatio-temporal Data Mining, Multimedia Data Mining, Text Mining, Mining the World Wide Web.	23	11, 12

References

1. *Data Mining – Concepts and Techniques - Jiawei Han & Micheline Kamber, Elsevier,3rd Edition.*
2. *Mehmed Kantardzic, Data Mining: Concepts, Models, Methods, and Algorithms, Wiley.*
3. *Data Mining Techniques – ARUN K PUJARI, University Press.*
4. *Building the DataWarehouse- W. H. Inmon, Wiley Dreamtech India Pvt. Ltd.*
5. *Data Warehousing in the Real World – Sam Anahory & Dennis Murray. Pearson Edn Asia.*
6. *Data Warehousing Fundamentals – Paulraj Ponnaiah Wiley Student Edition.*
7. *The Data Warehouse Life cycle Tool kit– Ralph Kimball Wiley Student Edition*

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Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work

Assessment Types	**Mode of Assessment**
	• **Continuous Internal Assessment (40%)**
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M. Sc. (Computer Science)**		
Course Name	**AI Lab**		
Type of course	**Core**	**Credit Value**	**2**
Course code	**IMSC805CS**		
Name of Faculty			
Course Summary& Justification	The Artificial Intelligence Lab complements theoretical knowledge with hands-on experience in implementing AI algorithms and techniques. Through practical exercises, students will gain proficiency in applying AI concepts to real-world problems and developing AI-powered solutions.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independant Learning etc..	-	-	108	12	120
Pre-requisite	Python programming					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Setting up the lab environment: IDEs, Python installations	C, U	1, 2
2	Introduction to essential libraries: NumPy, Pandas, Matplotlib	U, C, S	1, 2
3	Implement uninformed search strategies in Python	C, S	2, 3
4	Implement informed search strategies in Python	C, S	1, 3, 5
5	Implement propositional logic operations in Python	C, S, A	1, 2, 3
6	Implement game playing algorithms.	C, A, S	1, 2, 3, 7

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	Python IDE installation	23	1
2	Introduction to Python packages like NumPy, Pandas, Matplotlib	23	2
3	Design different uninformed search strategies	22	3
4	Design various informed search strategies	20	4
5	Perform propositional logic operations	12	5

6	Implement Game playing algorithms	8	6

References

1. *S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2015.*
2. *Elaine Rich and Kelvin Knight Artificial Intelligence, 3rd edition, Tata McGraw Hill, 2017.*
3. *Tony Gadis, Starting out with python,2ndedition Pearson Publications.*
4. *Peter Norton, Alex Samuel, David Aitel, Beginning Python, Wrox Publications.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** • Continuous Internal Assessment (CIA) (40 % marks) o Technical skills evaluation - Correctness of programs o Internal Tests – Minimum two (Practical) o Assignments - Lab Records, Practical and Viva o Case study • End Semester Examination (60 % marks)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Computer Science)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M. Sc. (Computer Science)**		
Course Name	**Cloud Computing**		
Type of course	**Elective**	**Credit Value**	**3**
Course code	**IMSE806CS-1**		
Name of Faculty			
Course Summary & Justification	The course covers the advanced concept of the configuration, distribution and management of data and infrastructure in all services. Areas include cloud service models, security, testing, infrastructure and its configuration.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	-	-	46	100

Pre-requisite	

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Determine the importance of Cloud Computing concept in the modern computing environment.	R,U	1,2,8
2	Understand various Cloud Models and service to manage the web-based applications.	A,S,E	1,3,4,5
3	Analysis and evaluate various cloud security requirements in secure development practice.	An,S ,E	2,3,4,5
4	Expertise in secure cloud software testing practice in software quality assurance.	U,A,C,	3,4,5
5	Recognize and management of cloud computing threats in infrastructure.	A,C,E	3,4,5
6	Formulate and evaluate possible solution of the virtual machine, and select and measure the chosen cloudenvironment.	An, S, C, E	1,3,4,5,6
7	Demonstrate the ability to analyze, design and apply cloud infrastructure to manage data.	E, U R, A	7, 8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	Cloud computing, History of Cloud Computing,Cloud service providers, Properties, Characteristics - Benefits of Cloud Computing- Cloud Stor-age-Cloud computing vs. Cluster computing vs. Grid computing-Role of Open Standards- Companies in the Cloud Today.	15	1,4

2	Web-Based Application, Pros and Cons of Cloud Service Development, The NIST model, Cloud Delivery Models- SaaS, PaaS, IaaS, Cloud deployment models- Private cloud, public cloud, community cloud, hybrid cloud, Alternative Deployment Models- The Linthicum Model, The Jericho Cloud Cube Model.	20	. 2,4
3	Security objectives, Services, Security design principles, secure development practice, Approaches to Cloud Software Requirements Engineering.	15	3,4
4	Secure Cloud Software Testing, Testing for SQA, Conformance, functional, Performance and security testing.	20	6
5	Threats to Infrastructure, Data and Access Control, Cloud Service Provider Risks- Back- Door, Spoofing, Man-in-the-Middle, Replay threats, TCP Hijacking, Social Engineering, Dumpster Diving, Password Guessing, Trojan Horses and Malware.	14	5,7

References

1. *Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH.*
2. *Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India.*
3. *M.N Rao, Cloud Computing, First Edition, PHI.*
4. *Das Gupta, Cloud Computing Based Projects using distributed Architecture, PHI.*
5. *Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers.*
6. *Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, Augus.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work

Assessment Types	**Mode of Assessment**
	• Continuous Internal Assessment (40%)
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M. Sc. (Computer Science)**		
Course Name	**Distributed Systems**		
Type of course	**Elective**	**Credit Value**	**3**
Course code	**IMSE806CS-2**		
Name of Faculty			
Course Summary& Justification	Distributed systems consist of a collection of independent computers that appears to its users as a single coherent system. This course aims to discuss some of the basic principles behind distributed systems, review main paradigms used to organize them and an introduction to distributed programming environment.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	-	-	46	100
Pre-requisite	Basics of Computer Networks					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand fundamentals of Distributed Systems	U, A, An	1,2,8
2	Elucidate Communication between Distributed Objects	U, E, A, An	1,2,3,4
3	Analyze Co-ordination and Agreement	U, An, E	1,2, 3
4	Illustrate Concurrency Control in DistributedTransactions	A, An, E	1,2, 7
5	Elucidate distributed programming environments	U, E, An, R	1,2,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Characterization of distributed systems** Introduction, Examples of Distributed Systems, Resource sharing and the Web, Challenges, Architectural models, Fundamental models, Networking issues	10	1
2	**Distributed Objects and Remote Invocation** Communication between Distributed Objects, Remote Procedure Call, Remote Method Invocation, Request Reply Protocol	10	2

3	**Overview of Clocks** Events and Process States, Synchronizing Physical Clocks, Logical time and Logical clocks, Coordination and Agreement: Overview of Distributed Mutual Exclusion- Central Server Algorithm and Ring-Based Algorithm, Elections-Ring based Election Algorithm.	14	3
4	**Distributed Transactions** Flat and Nested Distributed Transactions, Atomic Commit protocols, Concurrency Control in Distributed Transactions, Distributed Deadlocks, Transaction Recovery	12	4
5	**Distributed Shared Memory** Check pointing and Rollback Recovery- Consensus and Agreement- Failure Detectors- Distributed file servers- Distributed programming environments-Communication primitives, selected case studies**.**	8	5

References

1. *George Coulouris, Jean Dollimore, Tim Kindberg, Distributed Systems: Concepts and Design, Pearson Education Asia, 5th Edition.*
2. *Tanenbaum Andrew S. and Steen Maarten Van, Distributed Systems: Principles and Paradigms, 2nd Edition.*
3. *Sukumar Ghosh, "Distributed Systems", Chapman & Hall/CRC, Taylor & Francis Group.*
4. *Hagit Attiya, Jennifer Welch, "Distributed Computing: Fundamentals, Simulations, and Advanced Topics ", Wiley Publications.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work

Assessment Types	**Mode of Assessment**
	• Continuous Internal Assessment (40%)
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Data Analytics**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC901CS**		
Name of Faculty			
Course Summary& Justification	The main motive of the program is to enable students to create innovative solutions to real-time problems, the students are transformed to professionals by preparing them to critically analyze, design, and implement solutions based on strong theoretical and practical knowledge. Also provides the basic introduction to bigdata analysis.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	36	18	36	10	90
Pre-requisite	Should have good knowledge in machine learning and statistics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Define data science, its scope and applications.	U, An	1, 8
2	Describe the Data Science process and how its components interact.	U, E	1, 3
3	Differentiate data science and data analytics.	U, R	1, 2
4	Apply EDA and the Data Science process in a case study.	A, An	1, 8
5	Classify Data Science problems	R, C	1
6	Understand the concept of Bigdata	U, R	1, 8
7	Understand NoSL databases, HDFS and MapReduce.	U, R, E	1, 8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Fundamentals to Data Analytics** Introduction to Data Analytics: Sources and nature of data, classification of data (structured, semi-structured, unstructured), characteristics of data, need of data analytics, evolution of analytic scalability, analytic process and tools, analysis vs reporting, modern data analytic tools, applications	12	1

	of data analytics.		
2	**Data Analysis and Pre-processing** Data Analytics Lifecycle: Need, key roles for successful analytic projects, various phases of data analytics lifecycle – discovery, data preparation, model planning, model building, communicating results, operationalization. Data Pre-processing and Feature selection: Data cleaning - Data integration - Data Reduction - Data Transformation and Data Discretization, Feature Generation and Feature Selection, Feature Selection algorithms.	20	2,3
3	**Data Analysis Strategies** Application: Exploratory Data Analysis (EDA), statistical measures, Basic tools (plots, graphs and summary statistics) of EDA, Data Analytics Lifecycle, Discovery, EDA case study, Web scraping, Text data and Natural Language Processing. Data Visualization, Data Science and Ethical Issues, Discussions on privacy, security, ethics.	20	4,5
4	**Big Data** Bigdata – Concepts, Types and sources of Bigdata, Characteristics, Challenges of bigdata, Bigdata applications, Hadoop Distributors. NoSQL databases – Types of NoSQL databases, SQL vs NoSQL. Introduction to Hadoop, Features of Hadoop, Hadoop core components – HDFS, MapReduce, YARN.	20	6
5	**Hadoop Distributed File System** Hadoop Distributed File System (HDFS)- HDFS architecture, Applicability of HDFS, Processing data with Hadoop – MapReduce, MapReduce Examples. Hadoop ecosystem technologies – Data Ingestion: Sqoop, Flume, Data processing: Spark, MapReduce, Data Analysis: Pig, Hive, Impala, Coordination: Zookeeper, Database: HBase, Streaming: Flink, Storm.	18	7

References

1. *Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer*
2. *Tom White "Hadoop: The Definitive Guide" Third Edition, O'reily Media*.
3. *Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley.*
4. *Mining of Massive Datasets. v2.1, Jure Leskovek, Anand Rajaraman and Jefrey Ullman. Cambridge University Press.*
5. *Data Mining: Concepts and Techniques", Third Edition*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, • Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** • Continuous Internal Assessment (40%) o Internal Tests, Assignments, Seminar Presentation,

	Review Report • End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Advanced Data Structures**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC902CS**		
Name of Faculty			
Course Summary& Justification	The course covers the advanced concept of the design, analysis, and implementation of data structures and algorithms to solve problems using any programming language. Areas include elementary data structures, (including arrays, stacks, queues, and lists), advanced data structures (including trees, heap and graphs), the algorithms used to manipulate these structures, and their application to solving practical problems.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	36	18	36	10	100
Pre-requisite	The learner must have gained the fundamental concepts of Data Structure at bachelor level.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Define and develop data structure concept	A,An,S,E	1
2	Construct and categorize various list such as linkedlists, Shared and Recursive Lists; Heterogeneous Lists – Deterministic Skip Lists	C,A,S ,E	2, 3
3	Expertise in Hashing technique using construct and demonstrate Algorithms	U,A,An,C	1
4	Identify a problem and analyze it in terms of its significant parts and the information needed to solve using Search Structures.	A,An,S,E	1, 3
5	Manage and develop Heap Structures in problem solving aspects.	A,C,An,E	4
6	Formulate and evaluate possible Algorithms of the problems, and select and measure the chosen Algorithms	S,C,E	2,3
7	Demonstrate the ability to analyze, design, apply and use data structures and algorithms to solve engineering problems and evaluate their solutions.	An,U,R,,A	7

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction to Data Structures** Introduction to Data Structure: Overview, Types and Characteristics of Data Structure, Arrays, Stacks, Queues, Linked lists, Trees, Graphs.	18	1
2	**Linked Lists** Generalized linked lists, Representation, Recursive Algorithms, Reference Counts– Shared and Recursive Lists; Heterogeneous Lists – Deterministic Skip Lists. Hashing: - Separate Chaining; Open Addressing – Linear Probing – Quadratic Probing; Double Hashing – Rehashing – Extendible Hashing.	20	2,3
3	**Search Structures** Search Structures, 2-3 Trees – 2-3-4 Trees RdBlack Trees – B-Trees - Splay Trees – Digital Search Trees Tries – Differential Files – AATrees – Treaps – K Trees K-d Trees – Tries.	20	4,5
4	**Heap Structures** Heap Structures, Min-Max Heaps – D-heaps – Leftist Heaps – Binomial Heaps – Fibonacci Heaps – Binary Heaps – Skew Heaps – Pairing Heaps – Applications.	20	6
5	**Abstract Data Type** Abstract Data Type (ADT) – algorithms - concepts - definition - objectives of algorithms quality of an algorithm - space complexity and time complexity of an algorithm, Sorting, Searching and Application.	12	7

References

1. *Ellis Horowitz, Sartaj Sahni, Dinesh Mehta, Fundamentals of Data Structures in C++, 2nd Edition, Universities Press.*
2. *Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Second Edition, Pearson Education Asia.*
3. *Debashish Samanta, Classic Data Structures, PHI Second Edition.*
4. *Kutti, Padhye, Data Structures in C++, PHI, First Edition.*
5. *Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Addison-Wesley.*
6. *Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Silicon Press.*
7. *Richard F. Gilberg and Behrouz A. Forouzan, Data Structures: A Pseudocode Approach With C, Cengage Learning.*
8. *Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein, Data Structure using C, Prentice- Hall.*
9. *Robert Kruse, Tondo C L and Bruce Leung, Data Structures & Program Design in C, Pearson India, 2nd Edition.*
10. *Thomas H Cormen, Charles E Leiserson, and Ronald L Rivest, Introduction to Algorithms, 3rd Edition, Prentice Hall of India Private Limited.*
11. *Jean-Paul Tremblay, Paul G. Sorenson, P. G. Sorenson, Introduction to Data Structures with Applications, Mcgraw-Hill College.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, • Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	**Mode of Assessment**
	• Continuous Internal Assessment (40%)
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Advanced Computer Security**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC903CS**		
Name of Faculty			
Course Summary& Justification	This course offers an in-depth exploration of advanced techniques and strategies crucial for ensuring the integrity, confidentiality, and availability of digital systems and data. In an era marked by escalating cyber threats, this course is designed to provide students with a profound understanding of the principles and practices that underpin modern computer security. By delving into a range of advanced topics, the course equips learners with the knowledge and skills needed to mitigate risks and safeguard sensitive information from an array of cyber threats. Through a blend of theoretical instruction, hands-on exercises, and real-world case studies, this course not only fosters technical expertise but also cultivates a holistic mindset essential for addressing the ever-evolving landscape of cyber challenges. As organizations continue to grapple with the implications of cyberattacks, graduates of this course will be well-prepared to assume pivotal roles in ensuring the digital resilience of industries and enterprises.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	36	18	36	10	100
Pre-requisite	Cryptography and System Security					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Analyze static code and program vulnerabilities using open source tools.	U, An, A, S	1, 8
2	Identify malicious code and targeted malicious code.	U, A, An, S	5
3	Detect and counter threats to web applications.	An, A, S	8
4	Understand the vulnerabilities of Wi-Fi networks and explore different measures to secure wireless protocols, WLAN and VPN networks.	U, An	3
5	Use different forensic tools to acquire and duplicate data from compromised systems and analyse the same.	A, An, S, E	1, 8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction and Access Control** Cyber-attacks, Vulnerabilities, Defence Strategies and Techniques, Authentication Methods in Protocols, Defence in Depth Strategies. Access Control Policies: DAC, MAC, Multilevel Security Models – Biba Model, Bell La Padula Model, Single Sign on, Federated Identity Management.	14	1
2	**Program and OS Security** Malicious and Non malicious Programming Errors, Targeted Malicious Codes, Salami Attack, Linearization Attack, Covert Channel, Control Against Program Threats. OS Security: Memory and Address Protection, File Protection Mechanism, User Authentication. Linux and Windows: Vulnerabilities, File System Security.	20	1, 2
3	**Web Application Security** OWASP, Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross-Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, Web Service Security, OAuth 2.0	20	1, 2, 3
4	**Wireless Security** WIFI Security, WEP, WPA, WPA 2, Mobile Device Security – Security Threats, Device Security, GSM and UMTS Security, IEEE 802.11/802.11i Wireless LAN Security, VPN Security.	20	4
5	**Digital Forensics** Introduction to Digital Forensics, Acquiring Volatile Data from Windows and Unix systems, Forensic Duplication Techniques, Analysis of forensic images using open-source tools like Autopsy and SIFT, investigating logs from Unix and windows systems, Investigating Windows Registry.	16	5

References

1. *Computer Security, Dieter Gollman, Third Edition, Wiley*
2. *Digital Forensics by Nilakshi Jain & Kalbande, Wiley.*
3. *Incident Response & Computer Forensics by Kevin Mandia, Chris Prosise, Wiley.*
4. *Cyber Security. Nina Godbole, Sunit Belapure, Wiley.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, • Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** • Continuous Internal Assessment (40%), Internal Tests, Assignments, Seminar Presentation, Review Report • End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Computer Vision**		
Type of course	**Elective**	**Credit Value**	**3**
Course code	**IMSE904CS-1**		
Name of Faculty			
Course Summary& Justification	Computer vision seeks to develop algorithms that replicate one of the most amazing capabilities of the human brain, inferring properties of the external world purely by means of the light reflected from various objects to the eyes. We can determine how far away these objects are, how they are oriented with respect to us, and in relationship to various other objects. This is a field of computer science that focuses on enabling computers to identify and understand objects and people in images and videos. This course provides an introduction to computer vision including shapes, regions and boundaries, 3D vision, recent researches and applications.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	54	-	-	18	72

Pre-requisite	The learner must have gained the fundamental concepts of Data Structure at bachelor level.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand image processing fundamentals	U, An	1
2	Discuss shapes, regions and boundary tracking procedures	An, A, E	3
3	Understand Hough Transform	U, An	1
4	Illustrate 3D vision	U, A, An, C	7
5	Understand motion and types	U, A, C	3, 7
6	Discuss case Studies and recent researches in Computer Vision	U, An, A, C, E	7, 8
7	Illustrate applications of Computer Vision	A, An	7, 8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction to Image Processin** Image Processing Foundations: Review of image processing techniques; classical filtering operations; thresholding techniques; edge detection techniques; corner and interest point detection; mathematical morphology; texture.	8	1
2	**Shapes and Regions** Shapes And Regions: Binary shape analysis; connectedness; object labelling and counting; size filtering; distance functions; skeletons and thinning; deformable shape analysis; boundary tracking procedures; active contours; shape models and shape recognition; centroidal profiles; handling occlusion; boundary length measures; boundary descriptors; chain codes; Fourier descriptors; region descriptors; moments.	12	2
3	**Hough Transform** Hough Transform: Line detection; Hough Transform (HT) for line detection; foot-of-normal method; line localization; line fitting; RANSAC for straight line detection; HT based circular object detection; accurate centre location; speed problem; ellipse detection; Generalized Hough Transform (GHT); spatial matched filtering; GHT for ellipse detection; object location; GHT for feature collation.	10	3
4	**3D Vision** 3D Vision: Methods for 3D vision; projection schemes; shape from shading; photometric stereo; shape from texture; shape from focus; active range finding; surface representations; point-based representation; volumetric representations; 3D object recognition;3D reconstruction. Introduction To Motion: Triangulation; bundle adjustment; translational alignment; Parametric motion; spline-based motion; optical flow; layered motion	12	4, 5
5	**Case studies and Recent Researches** Case Studies and recent researches in Computer Vision: Applications like face detection, face recognition, eigen faces, surveillance, foreground-background separation, particle filters, Chamfer matching, tracking, and occlusion; combining views from multiple cameras; human gait analysis; locating roadway; road markings; identifying road signs; locating pedestrians.	12	6, 7

References

1. *D. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education.*
2. *J. Solem, Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images.*
3. *M. Nixon and A. Aquado, Feature Extraction & Image Processing for Computer Vision, 3rd Edition, Academic Press.*
4. *R. Jain, R. Kasturi, B. Schunck, Machine Vision, Indo American Books.*
5. *R. Szeliski, Computer Vision: Algorithms and Applications, Springer.*

Teaching and Learning	Class room Procedure (mode of transaction)

Approach	• Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, • Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** • Continuous Internal Assessment (40%) ◦ Internal Tests ◦ Assignments ◦ Seminar Presentation ◦ Review Report • End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Speech and Natural Language Processing**		
Type of course	**Elective**	**Credit Value**	**3**
Course code	**IMSE904CS-2**		
Name of Faculty			
Course Summary& Justification	This course offers a comprehensive exploration of key concepts essential to understanding and effectively working with spoken and written language. Through four integral modules, students delve into the intricacies of language processing. While the course primarily focuses on theoretical aspects, it equips students with foundational knowledge in phonetics, syntax, semantics, Natural Language Processing (NLP), word embeddings, and grammatical structures. This theoretical understanding forms a solid basis for students to engage with practical applications in related fields. Ideal for those interested in linguistics, computational linguistics, or AI-driven language technologies, this course provides a profound comprehension of Speech and Language Processing principles that can be applied in various real-world contexts.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	54	-	-	18	72
Pre-requisite	This course requires a foundational understanding of linguistics and basic programming concepts.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the fundamental concepts and steps of natural language processing.	U, R	1, 3, 7
2	Distinguish among the various NLP techniques, considering the assumptions, strengths, and weaknesses of each.	U, An, E	1, 7
3	Understand and analyse the semantics and pragmatics in terms of NLP.	U, An	1,7
4	Apply EDA and the Data Science process in a case study.	A, An	3
5	Classify Data Science problems	R, C	3
6	Understand the concept of Bigdata	U, R	3
7	Understand NoSQl databases, HDFS and MapReduce	U, R, E	6, 8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Words and Speech Fundamentals** Regular Expression and Automata, Words and Transducers, N-Grams, Part-of-Speech Tagging, Hidden Markov and Maximum Entropy Models. Phonetics, speech synthesis, Automatic Speech Recognition, Speech Recognition: Advanced Topics, Computational Phonology	5	1
2	**Natural Language Processing** Introduction to Natural Language Processing, History of NLP, Text Analytics and NLP, Various Steps in NLP, Tokenization, POS tagging, Stop word removal, Text normalisation, Spelling Correction, Stemming, Lemmatization, NER, Word Sense Disambiguation, Sentence Boundary Detection, Data Collection, Pre-processing.	8	2,3
3	**Semantics and Embeddings** Vector Semantics and Embeddings, Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF, Word2vec, Visualizing Embeddings, Semantic properties of embeddings, Evaluating Vector Models.	10	4,5
4	**Grammars** Formal Grammars of English, Syntactic Parsing, Statistical Parsing, Features and Unification, Language and Complexity. Semantics and Pragmatics- The Representation of Meaning, Computational Semantics, Lexical Semantics, Computational Lexical Semantics, Computational Discourse. Information Extraction, Question Answering and Summarization.	8	6,7

References

1. *Dan Jurafsky and James H. Martin, Speech and Language Processing, An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Prentice Hall series in artificial intelligence,2009.*
2. *Dwight Gunning: Sohom Ghosh, Natural Language Processing fundamentals, Packt Publishing.*
3. *Palash Goyal and Sumit Pandey, Deep Learning for Natural Language Processing: Creating Neural Networks with Python, Apress.*
4. *Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit, O'Reilly*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, • Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** • Continuous Internal Assessment (40%) ▪ Internal Tests, Assignments, Seminar Presentation, Review Report • B. End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Mobile Computing**		
Type of course	**Elective**	**Credit Value**	**3**
Course code	**IMSE904CS-3**		
Name of Faculty			
Course Summary& Justification	The purpose of this course is to prepare learners to understand the functionalities and design considerations of mobile computing. The course content is designed to cover the mobile computing architecture, features of different communication systems and major elements of mobile security and next generation computer systems. This course enables the learners to acquire advanced concepts on mobile and ad-hoc networks.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	54	-	-	18	72
Pre-requisite	The learner must have gained the fundamental concepts of Data Structure at bachelor level.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Describe the mobile computing applications, services, design considerations and architectures	U	3, 7
2	Identify the technology trends for cellular wireless networks	U, An	3, 7, 8
3	Summarize the Short Messaging Service and General Packet Radio Service	U	3
4	Outline the LAN technologies used in mobile communication	U	3, 7
5	Describe the security protocols and apply suitable security algorithm to secure the communication	A	1, 3, 7
6	Explain the fundamental concepts of next generation mobile networks	U	3, 8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Mobile Computing Architecture** Introduction to mobile computing – Functions, Devices, Middleware and gateways, Applications and services, Limitations. Mobile computing architecture – Internet: The ubiquitous network, Three-tier architecture, Design considerations for mobile computing.	8	1
2	**Communication Systems** Mobile computing through telephony - Evolution of telephony, Multiple access procedures - Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Space Division Multiple Access (SDMA). Satellite communication systems – Basics, Applications, Geostationary Earth Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Satellite phones. Mobile computing through telephone – Interactive Voice Response (IVR) architecture, Overview of voice software, Developing an IVR application. Global System for Mobile Communication (GSM) - Introduction, Architecture, Entities, Call routing, Mobility management, Frequency allocation, Authentication and security.	12	1, 2
3	**Short Messaging Service and General Packet Radio Service** Short Message Service (SMS) – Strengths, Architecture, Value added services, Accessing the SMS bearer. General Packet Radio Service (GPRS) – Architecture, Network operations, Data services, Applications, Limitations, Billing and charging.	12	3
4	**Wireless Local Area Networks** Wireless Local Area Network (WLAN) - Advantages, Evolution, Applications, Architecture, Mobility, Security, Deploying WLAN. Wireless Local Loop (WLL) – Architecture. High Performance Radio Local Area Network (HIPERLAN). WiFi Vs 3G.	10	4
5	**Mobile Security and Next Generation Networks** Security issues in mobile computing - Information security, Security techniques and algorithms, Security protocols. Next generation networks – The Converged Scenario, Narrowband to broadband, Orthogonal Frequency Division Multiplexing (OFDM), Multi-Protocol Label Switching (MPLS), Wireless Asynchronous Transfer Mode (WATM), Multimedia broadcast services.	12	5, 6

References

1. *Asoke K. Talukder, Hasan Ahmad, Roopa R Yavagal, Mobile Computing Technology- Application and Service Creation, 2nd Edition, McGraw Hill Education.*
2. *Schiller J., Mobile Communications, Pearson Education*
3. *Andrew S. Tanenbaum, Computer Networks, 6th edition, PHI.*
4. *Theodore S. Rappaport, Wireless Communications Principles and Practice, 2/e, PHI.*
5. *Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, • Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** • Continuous Internal Assessment (40%) ◦ Internal Tests ◦ Assignments ◦ Seminar Presentation ◦ Review Report • B. End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Introduction to Block Chain**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE905CS-1**		
Name of Faculty			
Course Summary& Justification	This course offers a comprehensive exploration of the fundamental principles, mechanics, and real-world applications of blockchain technology. Through five modules, students will gain an in-depth understanding of distributed systems, cryptographic foundations, consensus mechanisms, smart contracts, and decentralized applications. In response to the increasing demand for professionals skilled in blockchain technology, this course equips students with the knowledge to design and deploy blockchain solutions across industries.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	36	-	-	18	54
Pre-requisite	The learner must have gained the fundamental concepts of Data Structure at bachelor level.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the principles of cryptography and its role in ensuring data security in digital communication.	U	
2	Analyze the significance of cryptographic hashing and digital signatures in maintaining data integrity within a blockchain.	U, An	1,2
3	Describe the mechanics of Bitcoin transactions, including mining, validation, and the role of miners.	U, R	2,3
4	Examine the economic implications of cryptocurrencies, including their volatility, adoption, and potential as digital assets.	U, An	1, 3
5	Understand the role of Ether (ETH) in the Ethereum ecosystem and its use in transactions and gas fees.	U	7, 8
6	Explore the programming language Solidity and its application in creating Ethereum smart contracts.	U, A	7,8
7	Analyze the concept of blockchain scalability and the challenges faced by Bitcoin's Proof of Work (PoW) consensus mechanism.	U, An	3

8	Investigate real-world applications of blockchain technology across sectors, such as supply chain management, identity verification, and voting systems.	U, An	8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction of Cryptography and Blockchain** Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and Public Key Cryptosystems, Private vs. Public Blockchain.	6	1, 2
2	**Bitcoin and Cryptocurrency** Bitcoin, Bitcoin Network, Bitcoin Mining Process and Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double- Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.	8	3, 4
3	**Introduction to Ethereum** Ethereum protocol and payment model for code execution, Smart contract: design and implementation, Decentralized Applications (DAPP): design and implementation.	8	5, 6
4	**Advanced Blockchain Technology** Alternative data structure to Bitcoin's blockchain: directed acyclic graph (DAG), Proof-based consensus algorithms: proof of stake, proof of burn, proof of elapsed time, proof of luck, Voting-based consensus algorithms: byzantine fault tolerance algorithms, Case study: enterprise-level blockchains such as Hyperledger and Ripple.	8	7
5	**Blockchain Ecosystem and Applications** Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.	6	8

References

1. *Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing.*
2. *Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press.*
3. *Antonopoulos, Mastering Bitcoin, O'Reilly Publishing.*
4. *Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing.*
5. *D. Drescher, Blockchain Basics. Apress.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,

	• Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	**Mode of Assessment**
	• Continuous Internal Assessment (40%)
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Internet of Things**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE905CS-2**		
Name of Faculty			
Course Summary& Justification	This comprehensive Internet of Things (IoT) course covers a range of crucial topics to provide students with a holistic understanding of IoT technologies. Beginning with fundamental principles, the course ensures a strong foundational knowledge of IoT concepts. The course also imparts skills in handling and analyzing the substantial data generated by IoT devices, preparing students to derive meaningful insights. By demonstrating real-world applications across various sectors, the course allows students to recognize the diverse practical impacts of IoT technology. This balanced approach equips students with both theoretical insights and practical competencies, enabling them to confidently navigate the dynamic landscape of IoT.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	36	-	-	12	48
Pre-requisite	Solid understanding of programming concepts, data structures, and basic networking principles.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand and explain the fundamental concepts and components of IoT systems.	U, An	7, 8
2	Demonstrate proficiency in various wireless communication protocols and technologies used in IoT.	A	3
3	Recognize and evaluate real-world applications of IoT across industries.	U, A, E	7, 8
4	Analyze the impact of IoT on industries and society, recognizing its potential for transformative change.	U, A	5, 7
5	Design and implement sensor networks, considering factors such as network topology and data transmission efficiency.	U, A	7, 8
6	Adapt to emerging trends and think innovatively within the IoT domain.	U, An	8

7	Apply theoretical knowledge to design practical IoT solutions for real-world challenges.	A	1, 2, 8
8	Apply data analysis techniques to derive meaningful insights from IoT data, contributing to informed decision-making.	A	1

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Fundamentals of IoT** Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.	5	1,4
2	**Sensor Networks** Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, Raspberry Pi Development Kit, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.	8	1,2,3,5
3	**Wireless Technologies for IoT** Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus. IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols.	10	2,5,7
4	**Data Handling & Analytics** Introduction, Big Data, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications.	8	8
5	**Applications of IoT** Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.	5	6

References

1. *Hakima Chaouchi, "The Internet of Things Connecting Objects to the Web, Wiley Publications.*
2. *Olivier Hersent, David Boswarthick, and Omar Elloumi,"The Internet of Things: Key Applications and Protocols", WileyPublications.*
3. *Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT.*
4. *J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media.*
5. *Keysight Technologies, "The Internet of Things: Enabling Technologies and Solutions for Design and Test", Application Note.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, • Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	**Mode of Assessment**
	• Continuous Internal Assessment (40%)
	  ○ Internal Tests
	  ○ Assignments
	  ○ Seminar Presentation
	  ○ Review Report
	• End Semester Examination (60%)

School Name	**Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Minor Project**		
Type of course	**Core**	**Credit Value**	**2**
Course code	**IMSC907CS**		
Name of Faculty			
Course Summary& Justification	This course provides students with an opportunity to engage in independent research and practical implementation within the realm of computer science. This course empowers students to select and analyze a research paper, that aligns with their interests within the field. Through close collaboration with a designated supervisor or guide, students will delve into the chosen paper's concepts and methodologies, subsequently implementing their findings in a real-world context. The iterative process of submitting project reports and receiving feedback ensures steady progress and learning refinement. This course fosters critical thinking, technical competence, and project management skills, enabling students to contribute meaningfully to the advancement of computer science.		
Semester	**IX**		
Total Student Learning Time (SLT)	Total Learning Time		
	5 months		
Pre-requisite	A sound knowledge in any programming language and in-depth understanding of research papers in the concerned area.		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Select and comprehend a research paper, demonstrating the ability to identify pertinent research topics, dissect methodologies, and recognize the practical implications.	U, An	1, 3
2	Collaborate with a supervisor to define the scope and objectives of the chosen research paper's implementation, aligning project goals with the research's core concepts.	An, A	4, 7
3	Devise an implementation plan by designing a project architecture and formulating strategies that reflect the research paper's concepts, demonstrating a clear understanding of the practical application.	An, A	2
4	Implement the chosen research paper's concepts and methodologies, showcasing technical prowess and problem-solving skills through hands-on development.	A, S	1, 8
5	Identify and address challenges encountered during project implementation, displaying effective problem-solving abilities and resilience in overcoming obstacles.	U, An	6

6	Showcase the ability to contribute meaningfully to the field of computer science by practically applying research concepts, displaying a deep understanding of their practical implications.	S, A	8
7	Demonstrate effective project management skills, including time management, task prioritization, and project tracking, highlighting readiness for real-world project engagements.	S, A	8
** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module	Course Description	Months	CO No.
1	• This Minor Project course empowers students to individually select a research paper in any area of computer science. • Student collaborates with an assigned supervisor or guide to refine their project's scope and objectives. The course emphasizes a thorough understanding of the chosen paper's concepts and methodologies through literature review. • Practical implementation planning includes architecture design and strategy formulation. • With regular project report submissions, students receive constructive feedback, enabling iterative project refinement. • Troubleshooting challenges and documenting insights gained are integral to the implementation phase. • The course culminates in a project presentation and comprehensive report submission, fostering critical thinking, technical proficiency, and effective project management skills essential for contributing to the advancement of computer science.	5	1-5

Teaching and Learning Approach	**Laboratory Procedure (mode of transaction)** • Direct Instruction: Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training, Journal Club
Assessment Types	**Mode of Assessment** • Three project reviews, followed by presentations.(40 %) • Final Evaluation of the Project by 30 minutes presentation Examination Board consisting of the Chairman, both Internal and External Examiners at the End of Semester (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Major Research Project**		
Type of course	**Core**	**Credit Value**	**16**
Course code	**IMSC100PR**		
Name of Faculty			
Course Summary& Justification	As part of this course student is expected to carry out an Internship/ project work under the guidance of a research supervisor, in a reputed research/academic Institutions. This course will provide extensive training on methods and methodology of research in the area of study. Accordingly, the student shall acquire updated knowledge, skill and training on the area of research. At the end of this course student has to submit a detailed project report and present a seminar. It will be evaluated by the Examination Board consisting of both Internal and External Examiners..		
Semester	**X**		
Total Student Learning Time (SLT)	Total Learning Time		
	5 months		
Pre-requisite	Theoretical knowledge in Computer Science and programming skills		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Acquire sufficient Knowledge, training and skills to undertake independent, original and critical research on a relevant topic.	U, A, S, E, C	1-7
2	Gain expertise in Scientific literature survey and academic writing and develop interest for further research	S, I, AP	2,5,6,7,8
3	Skills to effectively present the objectives, methodology, analysis, and results of the research study.	S	3,4,6
4	Familiarize with advanced and modern research topics/trends	U, Ap	1,2,6,8
5	Capability to plan and use adequate methods to conduct specific tasks in given frameworks	A,An	1,2,7,8
6	Gain a consciousness of the ethical aspects of research	U, An	5-7
7	Create, analyze and critically evaluate different problems and their solutions	An, E, C	1,2,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Months	CO No.
1	Student shall carry out a 5 to 6 months of Research Project in a relevant area related to Computer Science and submit the project report/dissertation at the end of the course.	5-6	1-7

Teaching and Learning Approach	**Laboratory Procedure (mode of transaction)** • Direct Instruction: Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training, Journal Club
Assessment Types	**Mode of Assessment** • Evaluation of the Project by the Examination Board consisting of the Chairman, both Internal and External Examiners based on the quality and quantity of the project work done, Report, and • 30 minutes presentation at the End of the Semester (100 %)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Computer Science)**		
Course Name	**Comprehensive Viva Voce**		
Type of course	**Core**	**Credit Value**	**4**
Course code	**IMSC100VV**		
Name of Faculty			
Course Summary& Justification	The comprehensive viva-voce shall be conducted by the Examination Board consisting of the Chairman, Internal Examiner and External Examiner. A thorough understanding of all the M.Sc. level course contents and recent trends in the broad area of computer sciences are evaluated.		
Semester	**X**		
Total Student Learning Time (SLT)	Total Learning Time		
	-		
Pre-requisite	Thorough knowledge on all the M.Sc. level course contents she/he studied.		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Reproduce acquired knowledge/ understanding about the subject of study	R, U, A	1,2,3
2	Acquire more in-depth knowledge of the major subject of study and apply this knowledge in diverse contexts.	U, A, I	1,2,3,6,8
3	Develop problem solving ability by promptly analyzing /evaluating a problem	An, E, S	1,2,8
4	Increase communication skill and confidence of students by question answering and discussion.	S, I, Ap	3
5	Able to contribute to research and development work	I	1,6,7

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

Assessment Types	**Mode of Assessment** • A thorough understanding of all the M.Sc. level course contents and recent trends in the broad area of computer sciences are evaluated through questions and discussions by the board of examiners at the End of the Semester (100%)