

MAHATMA GANDHI UNIVERSITY

SCHOOL OF COMPUTER SCIENCES

M.Sc. Computer Science

Scheme and Syllabi in OBE Framework from 2021 Admission onwards

(based on CSS 2020 Regulations)

SUBMITTED IN December 2021

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)

Vision

To emerge as a centre of excellence in knowledge generation and dissemination for moulding technically competent and socially committed computer scientists/professionals for nation building.

Mission

To provide a conducive environment for teaching, research and learning leading to the overall holistic development of students

To foster research and extension activities for the development of the society

To develop skilled manpower for providing intellectual leadership to the community so as to meet global demands

MAHATMA GANDHI UNIVERSITY

SCHOOL OF COMPUTER SCIENCES

SCHEME 2021

PROGRAMME: M.Sc. Computer Science FACULTY OF SCIENCE

DURATION: <u>4 Semesters</u> Minimum Total Credits Required: <u>84</u>

Revised Syllabus 2021: Semester wise List of Courses

<u>Semester I</u>						
Course Code	Course Title	H	ours/We	Cradits		
Course Coue	Course ritte	L	Т	Р	Creuits	
CO M 21 C 11	Operating Systems and Virtualization	3	1	2	4	
CO M 21 C 12	Multicore Microprocessors and Parallel Programming	3	2	3	4	
CO M 21 C 13	Algorithms and Complexity	3	2	3	4	
CO M 21 C 14	Artificial Intelligence	3	2	-	4	
CO M 21 E 1*	Elective – I	3	1	2	3	
CO M 21 C 15	Case Study using Python-Lab	-	1	6	2	
	Total Credits (Semester I)				21	
	Semester I	I				
CO M 21 C 21	Machine Learning	3	1	2	4	
CO M 21 C 22	Digital Image Processing	3	2	3	4	
CO M 21 C 23	Data Mining	3	2	3	4	
CO M 21 C 24	Software Engineering	3	-	2	4	
CO M 21 E 2*	Elective – II	3	1	2	3	
CO M 21 C 25	Minor Project using Advanced Java and Object Oriented Analysis and Design –Lab	-	1	6	2	
	Total Credits(Semester II)				21	
	Semester III					
CO M 21 C 31	Theoretical Computer Science	3	2	-	4	
CO M 21 C 32	Deep Learning	3	2	1	4	
CO M 21 E 3*	Elective – III	3	1	2	3	
CO M 21 E 3*	Elective – IV	3	1	2	3	
CO M 21 C 33	Deep Learning-Lab	-	1	6	2	
CO M 21 C 34	Advanced Software Development Tools-Lab	-	1	3	2	
CO M 21 O 31	Open Course	3	1	2	4	
	Total Credits(Semester III)				22	
Semester IV						

Semester 1V							
CO M 21 C 41	Main Project& Comprehensive Viva-voce	One Semester	20				
	Total Credits(Semester IV)		20				

Total Credits for the M.Sc. Programme : 84

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ELECTIVES

	Course Title		Hours/W		
Course Code			Т	Р	Credits
CO M 21 E 11	Cyber Security and Cyber Laws	3	1	2	3
CO M 21 E 12	Advanced Data Structures	3	1	2	3
CO M 21 E 13	3D Graphics	3	1	2	3
CO M 21 E 21	Wireless Communication and Sensor Networks		1	2	3
CO M 21 E 22	Cyber Physical Systems	3	1	2	3
CO M 21 E 23	Distributed Systems and Parallel Computing	3	1	2	3
CO M 21 E 31	Data Science	3	1	2	3
CO M 21 E 32	Internet Of Things and Block Chain Technologies		1	2	3
CO M 21 E 33	Cloud Computing	3	1	2	3
CO M 21 E 34	Fuzzy Logic and Nature Inspired Computing	3	1	2	3
CO M 21 E 35	Natural Language Processing	3	1	2	3
CO M 21 E 36	Digital Signal Processing and Speech Technologies		1	2	3



Mahatma Gandhi University

Graduate Attributes

Critical Thinking and Analytical Reasoning Scientific Reasoning and Problem Solving	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 toenvisage the reflective thought to the implication on the society. 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.
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 collaborativemultidisciplinary/ interdisciplinary/transdisciplinary- approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.
Intra and Interpersonal Skills	Ability to work effectively and respectfully with diverse teams; facilitate collaborative and coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team; lead the team to guide people to the right destination, in a smooth and efficient way.
Digital literacy	Capability to use ICT in a variety of learning situations, demonstrate ability to access, choose, collect and evaluate, and use a variety of relevant information sources; structure and evaluate those data for decision making.
Global Citizenship	Building a sense of belonging to a common humanity and to become responsible and active global citizens. Appreciation and adaptation of different sociocultural setting.
Social Competency	Possess knowledge of the values and beliefs of multiple cultures, appreciate and adapt to a global perspective; and capability to effectively engage in a multicultural society and interact respectfully, manage and lead with diverse groups.
Equity, Inclusiveness and	Appreciate and embrace equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity,

Sustainability	secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity
Lifelong Learning	Continuous acquisition of knowledge and skills. Learn, unlearn and relearn based on changing ecosystem. "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 work place through knowledge/skill development/reskilling.

Programme Outcomes (PO)

PO 1: Critical thinking and Analytical reasoning

Capability to analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.

PO 2 : Scientific reasoning and Problem solving

Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; 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 express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; 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 to different groups.

PO 5: Leadership Skills

Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, 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 (caste, ethnicity, gender and marginalization), 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, avoid unethical behaviour

PO 9: Networking and Collaboration

Acquire skills to be able to collaborate and network with educational institutions, research organisations and industrial units 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 work place through knowledge/skill development/reskilling.

<u>M.Sc. Computer Science</u> <u>Programme Specific Outcomes (PSO)</u>

PSO1	Critical Thinking and Evaluation Critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective;
PSO2	Scientific Analysis and Reasoning Ability to analyse, discuss, interpret and draw conclusions from quantitative/ qualitative data and experimental evidences;
PSO3	Problem Solving Capacity to extrapolate and apply their knowledge and competencies to solve problems and contextualise into research and develop relevant software solutions to real life problems.
PSO4	Multidisciplinary/Interdisciplinary/Transdisciplinary Approach Acquiring knowledge and formulating solutions in interdisciplinary/ multidisciplinary/transdisciplinary levels for problem solving in a collaborative environment.
PSO5	Communication Skills Ability to document, present and demonstrate complex problem solutions in a very clear and effective way with the aid of appropriate tools.
PSO6	Leadership Skills Ability to work effectively and lead respectfully with diverse teams, formulating a goal in a smooth and efficient way.
PSO7	Social Consciousness and Responsibility Ability to evolve as a socially committed and responsible scientist/software professional meeting global demands.
PSO8	Moral and Ethical Reasoning Capable of demonstrating the ability to identify ethical issues related to software development and use ethical practices in all phases of software development/deployment and research and embrace moral/ethical values in conducting one's life.
PSO9	Networking and Collaboration Acquire skills to be able to collaborate and network with scholars in an educational/, professional/research/industry organizations and individuals in India and abroad.
PSO10	Lifelong Learning Ability to acquire knowledge and skills through self-paced and self-directed learning and adapt to changing trends and demands of work place through knowledge/skill updation/reskilling.



COM21C11 OPERATING SYSTEMS AND VIRTUALIZATION

FIRST SEMESTER

School Name	School of Computer Sciences						
Programme	M. Sc.						
Course Name	Operating S	ystems an	d Virtuali	ization			
Type of Course	Core						
Course Code	COM21C11						
Names of Academic Staff & Qualifications	Prof. Dr. Bin	du V R, M	[. Sc., Ph.]	D.			
Course Summary & Justification	The course p operating sys and current d students will implementati students will virtualization to be able to concepts, fou	The course provides a thorough discussion on the fundamentals of operating system design, relating these to contemporary design issues and current directions in the development of operating systems. The students will getacquainted with the design principles and implementation issues of contemporary operating systems. The students will also get a deep 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	Ι	Ι					
Total Student Learning Time (SLT)	Learning Approach	Lectur e	Tutoria l	Practica 1	Other s	Total LearningHour s	
	Explicit Teaching Seminar, Assignment , case Study etc.	42	14	28	36	120	
Pre-requisite	Overview of Memory, Sch	Computer eduling. I	System ar nput/Outp	nd Operatin ut and Files	ig System	n – Processes,	



COM21C11 OPERATING SYSTEMS AND VIRTUALIZATION

COURSE OUTCOMES (CO)

CO No	Expected Course Outcome	Learning	PSO No.				
INO.		Domains					
1	Analyse the key design areas that have been instrumental in the development of modern operating systems	U, An	1				
2	Elucidate OS design issues raised by the introduction of multiprocessor and multicore organization.	An	1,2				
3	Compare and Analyse the structure, functional elements and features of Windows, Traditional and Modern UNIX, Linux and Android operating systems.	An	1,2,4				
4	Critically examine the requirements for process control by the OS and analyse the issues involved in the execution of OS code.	A, An	1,2,				
5	Develop programs implementing multithreading.	U, A	1,2,3,4				
6	Compare and Analyse the process and thread management, the concurrency and synchronization methods and the virtual memory management mechanisms in UNIX, Linux, Solaris, Windows and Android operating systems.	R, U, An	1,2				
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	1,2,3				
8	Analyse and compare the scheduling methods used in Linux, UNIX SVR4, and Windows 10.	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	1,2				
10	Define and discuss virtual machines and virtualization and conceptualize and implement the various approaches to virtualization.	U, A, An	1,2,3				
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	1,2,3,5,6,1 0				
*Remen	*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)						

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COM21C11 OPERATING SYSTEMS AND VIRTUALIZATION

COURSE CONTENT Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	СО
			No.
UNIT I	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.	12	1,2,3
UNIT II	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 Interprocess Communication. NIX and Solaris Memory Management, Linux Memory Management, Windows Memory Management, Android	20	4,5,6,1 1 7,8,11
UNIT III	Management, Windows Memory Management, Android Memory Management. Scheduling - Traditional UNIX Scheduling, Multiprocessor and Multicore Scheduling, Real-time Scheduling, Linux Scheduling, UNIX SVR4 Scheduling, Windows Scheduling.	16	
UNIT IV	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.	16	9,11
UNIT V	Virtualization Concepts: Introduction to 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, Linux VServer Virtual Machine Architecture, Android Virtual Machine.	20	10,11



COM21C11 OPERATING SYSTEMS AND VIRTUALIZATION

Teaching and	Classroom Procedure (Mode of transaction)							
Learning	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning,							
Approach	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							
	A. Continuous Internal Assessment (CIA)							
	• Internal Tests – Minimum Two (Extended answers / Practical)							
	• Seminar –							
	Research Literature Review							
	Report Writing							
	 Presentation 							
	• Assignment – Written, Practical, Oral Presentation and Viva							
	Case study/ Mini project							
	B. Semester End Examination							

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.



COM21C12 MULTICORE MICROPROCESSORS AND PARALLEL PROGRAMMING

School Name	School of Com	puter Scie	nces				
Programme	M.Sc.						
Course Name	Multicore Micr	Multicore Microprocessors and Parallel Programming					
Type of Course	Core						
Course Code	COM21C12						
Names of Academic Staff & Qualifications	Prof. Dr. Pushpalatha K P, PhD						
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 based on various models, memory subsystem including cache architectures. It also gives training in parallel programming with OpenCL for massively parallel GPUs. The students after studying this course will be able to know the architecture and working of Pentium mircroprocessor and multicore mircroprocessors within a computer. They can understand and apply parallel programming structures and constructs using MPI and OpenCL with Multiple GPU cores for solving problems that need to handle huge quantity of data. Thus they will be equipped with various technical and programming skills to generate parallel executable software. They can get placed in jobs like hardware designers, system software engineers etc. and they are paid more than a						
Semester	I				1		
Total StudentLearningTim e (SLT)	Learning Approach	Lecture	Tutoria 1	Practica 1	Other s	Total Learning Hours	
	Explicit4228428120Teaching Seminar, Assignments etc.428120						
Pre-requisite	Knowledge in 80	86 or 80x86	6 Microproc	cessors			



COM21C12 MULTICORE MICROPROCESSORS AND PARALLEL PROGRAMMING

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.
No.		Domains	
1	Understand the difference in the features of single core	U	2
2	microprocessors and multicore microprocessors.	TT A	1.0
2	Conceptualise the specific features of a parallel computer through Flynn's Taxonomy.	U, An	1, 2
3	Illustrate the application of various parallel architectures of Intel Core ix.	U, R, An	2, 3
4	Develop and test software that can do process to process communication usingOpenMP.	A, An, C	2, 5, 8, 10
5	Demonstrate the interconnection networks possible within a multicore architecture.	R, U, E	1, 2, 3, 5, 10
6	Evaluate the performance of microprocessors based on memory hierarchy, cache performance and cache designing.	A, An, E	1, 2, 3
7	Research, identify and create alternate solutions for the basic Cache Coherence Issues	An, A, C	2, 3, 7, 10
8	Demo the application of the features of OpenCL to solve problems that needs massively Parallel data handling operations with GPU processors.	A, C, S	3, 4, 5
9	Prepare a report and do a presentation on the comparative study of the applications of MPI and OpenCL on various parallel architectures of Intel Core.	U, R, An	2, 3, 5, 8
10	Document, present and demonstrate concepts of parallel programming in a very clear and effective way with the aid of appropriate tools.	An, E, C	2, 5, 8
*Reme Skill (S	mber (R), Understand (U), Apply (A), Analyse (An), Evalu S)	uate (E), Crea	ete (C),



COM21C12 MULTICORE MICROPROCESSORS AND PARALLEL PROGRAMMING

COURSE CONTENT Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO
			No.
UNIT I	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.	20	1,2
UNIT II	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.	22	3,5
UNIT III	Shared Memory Parallel Programming using OpenMP, 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.	24	4
UNIT IV	Introduction to Memory Hierarchy Organization, Basic Architectures of a Cache, Cache Performance, Prefetching, Cache Designing, Multicore Architecture, Physical Cache Organization, Logical Cache Organization, CaseStudies. Introduction to Shared Memory Multiprocessors, Basic Cache Coherence Issues, Hardware Support for Synchronization, Memory Consistency Models, Advanced Cache Coherence Issues.	22	6,7
UNIT V	OpenCL for Massively Parallel Graphic Processors, Anatomy of a GPU, Programmer's View of OpenCL, Programming in OpenCL.	24	8,9,10



COM21C12 MULTICORE MICROPROCESSORS AND PARALLEL PROGRAMMING

Teaching and	Classroom Procedure (Mode of transaction)					
Learning	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning,					
Approach	Interactive Instruction: Active co-operative learning, Seminar, Group					
	Assignments					
	Authentic learning: Library work and Group discussion, Presentation by					
	individual student/Group representative.					
Assess	Mode of Assessment					
ment Types	A. Continuous Internal Assessment (CIA)					
	• Internal Tests – Minimum two (Extended answers / Practical)					
	• Seminar –					
	 Research Literature review 					
	 Report writing 					
	 Presentation 					
	• Assignments – Written, Practical, Oral presentation and viva					
	Case study/Mini project					
	B. Semester End Examination					

REFERENCES

- 1. A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals-Architectures, 3e, McGrawHill Education (India)Pvt. Ltd.
- 2. Berry.B.Brey, The Intel Microprocessors 8086/8088 /80186/80188, 80286, 80386,80486 PENTIUM, PENTIUM Pro, PII, PIII & IV Architecture, Programming & Interfacing, Pearson Education..
- 3. Roman Trobec, BoštjanSlivnik Patricio Bulić, BorutRobič, Introduction to Parallel Computing From Algorithms to Programming on State-of-the-Art Platforms, Springer Nature Switzerland AG 2018, ISSN 1863-7310 ISSN 2197-1781 (electronic).
- 4. Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press.
- Thomas Rauber, GudulaRunger, Parallel Programming for Multicore and Cluster Systems, Second Edition, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-37800-3.
- 6. AaftabMunshi, Benedict R. Gaster, Timothy G. Mattson, James Fung, Dan Ginsburg, OpenCL Programming Guide, Addison-Wesley, Pearson Education Inc.
- 7. David W. Walker, Parallel Computing, Encyclopedia of Physical Science and Technology (Third Edition).



COM21C13 ALGORITHMS AND COMPLEXITY

School Name	School of Compu	School of Computer Sciences				
Programme	M.Sc.					
Course Name	Algorithms and (Complexit	y			
Type of Course	Core					
Course Code	COM21C13					
Names of Academic Staff & Qualifications	Dr. Anuj Mohamed, MCA,Ph. D.					
Course Summary & Justification	This course provides knowledge of techniques to design efficient algorithms to solve various types of problems and to make evaluative judgments about the algorithms. It also covers techniques to establish the efficiency of the designed algorithms. It also provides concepts of NP- completeness and to evaluate algorithms accordingly.					
Semester	Ι					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar Assignments etc.	42	28	42	8	120
Pre-requisite	Design and A Programming Sk	Analysis ills	of Al	gorithms,	Data	Structures,



COM21C13 ALGORITHMS AND COMPLEXITY

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.	
1	Analyse a given algorithm and express its time and space complexities in asymptotic notations.	U, An	1,2, 5	
2	Solve recurrence equations using different methods.	Ар	2, 3	
3	Describe various techniques for deriving good lower bounds.	U	2,5	
4	Compute the lower bound on the time of an algorithm	A,E	2,3	
5	Understand the concept of nondeterministic algorithms	U	1,2	
6	Describe computational models for parallel algorithms	U	1,5	
7	Implement parallel algorithms for suitable applications	An, C	3	
8	Understand concepts of NP-completeness and evaluate algorithms accordingly	U, An, E	1,2,8	
9	Distinguish between problems that can be solved by a polynomial time algorithm and problems for which no polynomial time algorithm is known	U, An, E	1,2	
10	Apply approximation algorithms to generate feasible solutions for NP-hard problems.	U, A	2,3	
11	Design algorithms to solve real-life problems, analyze its complexity and present the approach in an effective way with the aid of appropriate tools.	U,An, C,E	1,2,3,5,8	
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, 10	
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)				



COM21C13 ALGORITHMS AND COMPLEXITY

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction: The Role of Algorithms in Computing, Design and Analysis Fundamentals, Performance Analysis, Mathematical Background for Algorithm Analysis, Recurrences: Substitution Method, Recursion-Tree Method, Master Method.	16	1,2
UNIT II	Lower Bound Theory: Importance of Lower Bound Theory, Comparison Trees, Adversary Arguments, Lower Bounds through Reductions.	22	3,4
UNIT III	String Matching Algorithms: The Naive String Matching Algorithm, The Rabin-Karp Algorithm, String Matching with Finite Automata, The Knuthmorris-Pratt Algorithm, Longest Common Subsequence.	26	5
UNIT IV	Parallel Algorithms: Sequential vs. Parallel Algorithms; Models: Data Parallel Model, Task Graph Model, Work Pool Model, Master Slave Model, Producer Consumer or Pipeline Model; Hybrid Model; Speedup and Efficiency; Examples of Parallel Algorithms: Parallel Sorting, Parallel Matrix Chain Multiplication.	26	6,7
UNIT V	Introduction to NP-Completeness: The class P and NP, NP-Complete, NP-Hard, NP- Completeness and Reducibility; Cook's Theorem.Approximation Algorithms: Absolute Approximations, C- Approximations, Polynomial Time and Fully Polynomial Time Approximation Schemes. Vertex Cover Problem, Traveling-Salesman Problem.	22	8,9,10,11,1 2



COM21C13 ALGORITHMS AND COMPLEXITY

Teaching and Learning	Classroom 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 A. Continuous Internal Assessment (CIA)					
	 Internal Tests – Minimum two (Extended answers / Tractical) Seminar – Research Literature review Report writing Presentation Assignments – Written, Practical, Oral presentation and viva Case study/Mini project B. Semester End Examination 					

REFERENCES

- 1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, Prentice Hall India, Third Edition.
- 2. G. Brassard, P. Bratley, Fundamentals of Algorithms, PHI.
- 3. Ellis Horowitz, SartajSahni, SanguthevarRajeshekharan, Computer Algorithms/C++, Second Edition, Universities Press.
- 4. A. Levitin, Introduction to Design and Analysis of Algorithms, Pearson.
- 5. Basu S.K., Design Methods and Analysis of Algorithms, Prentice Hall, Second Edition.
- 6. A. Bhargava, Grokking Algorithms: An illustrated guide for programmers and other curious people, Manning Publications.
- 7. A. Basheer, M. Zaghlool, FPGA-Based High Performance Parallel Computing, Scholars' Press.
- 8. Richard Neapolitan, KumarsNaimipour, Foundations of Algorithms, Jones and Barlett Publishers, Canada, Fourth Edition.
- 9. Sara Base Allen Van Gelder, Computer Algorithms: Introduction to Design and Analysis, Pearson Education Asia.
- 10. Prabhakar Gupta, Vineet Agarwal, Manish Varshney, Design and Analysis of Algorithms,



COM21C14 ARTIFICIAL INTELLIGENCE

Prentice Hall India, Second Edition.

School Name	School of Com	School of Computer Sciences					
Programme	M.Sc.						
Course Name	Artificial Intelli	gence					
Type of Course	Core						
Course Code	CO M 21 C 14						
Names of Academic Staff & Qualifications	Dr. Ivy Prathap, Ph.D.						
Course Summary & Justification	Today, the amount of data that is generated by both humans and machines far outpaces human ability to absorb, interpret, and make complex decisions based on that data. Artificial intelligence forms the basis for all computer learning and is the future of all complex decision making. This course aims to introduce the basic concepts, theories, state-of-the-art techniques and applications of artificial intelligence						
Semester	I						
Total StudentLearningTim e (SLT)	Learning Approach	Lecture	Tutoria 1	Practica 1	Other s	Total Learning Hours	
	Explicit Teaching Seminar, Assignments etc.	42	28	-	50	120	
Pre-requisite	Basics of Data S	Structures	and Algor	ithms			



COM21C14 ARTIFICIAL INTELLIGENCE

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand fundamentals of Artificial Intelligence and expert systems	U	1,2,10
2	Elucidate state space and searching strategies	Е	2,10
3	Analyze various types of standard search algorithms	An	3,10
4	Illustrate advanced search techniques and algorithms like minmax for game playing.	А	3,9,10
5	Examine Knowledge representation and predicate logic	А	1,10
6	Investigate the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.	E	2,10
7	Apply the machine learning concepts in real life problems.	А	1,9,10
*Remen	nber (R), Understand (U), Apply (A), Analyse (An), Evaluate (I	E), Create (C), S	Skill (S)

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction to Artificial Intelligence: Definition of AI; Future of AI; Brief Discussion of Major Topics (Expert System, Natural Language Processing, Speech and Pattern Recognition etc.) of AI. Problem Definition as a State Space Search, Production System, Control Strategies, Problem Characteristics.	6	1,2
UNIT II	Types of search algorithms: Formal vs. Informal search: Breadth First Search, Depth First Search, iterative deepening, uniform cost search, Hill climbing and its Variations, simulated annealing, genetic algorithm search; Heuristics Search Techniques: Best First Search, A* algorithm, AO* algorithm, Min-max & game trees, refining	20	3



COM21C14 ARTIFICIAL INTELLIGENCE

	minmax, Alpha – Beta pruning, Constraint Satisfaction Problem, Means-End Analysis.		
UNIT III	Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic- Structured representation of knowledge.	16	4,5
UNIT IV	Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.	14	6
UNIT V	AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware –Perception – Planning – Moving.	14	7

Teaching and	Classroom Procedure (Mode of transaction)				
Learning 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	Mode of Assessment				
Types	A. Continuous Internal Assessment (CIA)				
	• Internal Tests – Minimum two (Extended answers)				
	• Seminar –				
	 Research Literature review 				
	 Report writing 				
	 Presentation 				
	• Assignments – Written, Oral presentation and viva				
	• Case study				
	B. Semester End Examination				



COM21C14 ARTIFICIAL INTELLIGENCE

REFERENCES

- 1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education.
- 2. Elaine Rich and Kelvin Knight, Artificial Intelligence, 3rd edition, Tata McGraw Hill.
- 3. M. Tim Jones, Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, First Edition.
- 4. Nils J. Nilsson, Artificial Intelligence: A new Synthesis, Harcourt Asia Pvt. Ltd.
- 5. George F. Luger, Artificial Intelligence-Structures and Strategies For Complex Problem Solving, Pearson Education.



COM21C15 CASE STUDY USING PYTHON-LAB

School Name	School of Compu	ter Science	es			
Programme	M.Sc.					
Course Name	Case Study using	Python-La	ıb			
Type of Course	Core					
Course Code	COM21C15					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose	e, M.Tech.				
Course Summary & Justification	The course provides an insight into the fundamentals of Python programming. It covers programming environment, important instructions, data representations, database connectivity and object- oriented design of Python. This course lays the foundation to develop Web applications, Machine Learning, Artificial Intelligence-based applications, Data Science and Data Visualization applications.					
Semester	Ι					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutoria 1	Pract ical	Others	Total Learning Hours
	Explicit Teaching Assignments, Viva, Record Preparation etc.	-	14	84	22	120
Pre-requisite	Basic knowledge	of any pro	gramming	language	e concepts.	



COM21C15 CASE STUDY USING PYTHON-LAB

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.		
No.		Domains			
1	Write, test and debug Python programs in interactive	А	1,2,3		
	mode and script mode				
2	Familiarize with variables, keywords, operators,	U			
	expressions, input-output, data types and functions of		1,2,3		
	python.				
3	Apply built in functions, modules and packages to	А	1,2,3,4,7		
	solve real world problems.		10		
4	Illustrate the uses of assignment statements,	А	1,2,3,4		
	conditional and iterative statements in Python				
5	Choose an appropriate Data Structure like Lists,	An	1,2,3,4,7,1		
	Tuples, Sets and Dictionaries of Python for solving a		0		
	problem.				
6	Discover the capabilities of Python regular expression	S	1,2,3,4,7,1		
	for data verification.		0		
7	Interpret the concepts of Object-oriented programming	E	1,2,3,4,7,1		
	in Python using polymorphism and inheritance.		0		
8	Develop database programs and establish database	С	1,2,3,4,		
	connectivity using MySQL		7,10		
*Reme	mber (R), Understand (U), Apply (A), Analyse (An), Eva	luate (E), Cre	eate (C),		
Skill (S)					

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Python interpreter, invoking the interpreter, arguments passing, executable python scripts, python data types, collections, input output data, built in functions.	18	1
UNIT II	Operators (unary, arithmetic, etc.) Data types, variables, expressions, and statements Assignment statements -Control Structures: loops and decision.	18	2,4

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21C15 CASE STUDY USING PYTHON-LAB

UNIT III	Modularization and Classes - Standard modules Packages Defining Classes Defining functions Functions and arguments - Exceptions and data structures Data Structures (array, List, Dictionary) Error processing Exception Raising and Handling.	22	3,5
UNIT IV	Regular expression in python, searching, matching, splitting, grouping string programs- Object Oriented Programming Object Oriented Design Inheritance and Polymorphism	20	6,7
UNIT V	Database programs in python-Installing MYSQL, connectivity using MYSQL, create database instance and using with python, MSQLdb module with python.	20	8

Teaching and	Classroom Procedure (Mode of transaction)							
Learning								
Approach	Explicit Teaching, E-learning, Active co-operative learning, Inquiry based							
	instruction, Authentic rearining, Exorary work and Group discussions							
Assessment	Mode of Assessment							
Types								
	A. Continuous Internal Assessment (CIA)							
	• Technical skills evaluation - Correctness of programs							
	• Internal Tests – Minimum two (Practical)							
	 Assignments -Lab Records, Practical and Viva 							
	• Case study							
	•							
	B. Semester End Examination							

REFERENCES

- 1. Starting out with python by Tony Gadis ,2nd edition Pearson Publications
- 2. Python: From Novice to Professional by Magnus Lie Hetland-Apress
- 3. Python 2.6 Bible Dave Breuck and Stephen Tanner-Hungry minds Ins.
- 4. Beginning Python Peter Norton, Alex Samuel, David Aitel-wrox publications
- 5. Python Essential Reference-David M Beazley second Edition



MAHATMA GANDHI UNIVERSITY

School of Computer Sciences

COM21E11 CYBER SECURITY AND CYBER LAWS

ELECTIVES

Name of School	School of Computer Sciences						
Programme	M. Sc						
Name of Course	CYBER SEC	CURITY A	AND CYB	ER LAWS			
Type of Course	Elective						
Course Code	CO M 21 E 1	1					
Names of	Dr. Abdul Jab	bar P, MI	Phil, PhD				
Academic Staff							
&	Ph. D						
Qualifications							
Course	The course is	focused o	n the conce	ept of cyber	security and	cyber law.	
Summary &	Areas include	Proxies,	Tunneling	technique, l	Fraud techni	que, Brute	
Justification	force and dict	tionary att	acks, Cros	s site scripti	ng, Social e	ngineering	
	and protection	and protection of information using cyber laws. Finally it concludes					
	pointing out future development in cyber security and law. The learner						
	is capable of using cyber space in the industry for defending attacks.						
Semester	Ι						
Total Student	Learning						
Learning Time	Approach	Lectur	Tutoria	Practical	Others	Total	
(SLT)		e	1			Learnin	
						g Hours	
	Explicit	42	14	28			
	Teaching						
						120	
	Seminar,				36		
	Assignment						
	s etc.						
Pre-requisite	The learner m	ust have g	gained the	fundamental	concepts of	cyber	
	security and information interchange.						



COM21E11 CYBER SECURITY AND CYBER LAWS

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.		
1	Understand the significance of cyber security, cryptography and cyber laws.	R, U	1,2,10		
2	Recognize and understand the characteristics of attackers technique and motivations.	A,An,S,E	3,4,5		
3	Identify and compare various cyber attacks to protect information.	C,An, S, E	3,5,7,8		
4	Analyse and evaluate various cyber law based infamous cyber crime(civil and criminal cybersecurity offenses)	U,A,An,E	2,8,9,10		
5	Develop and update future development in cyber security law, cyber privacy and data protection law.	A,C,An,E	1,3,4,8,9		
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)					

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction to Cyber Security; Information security, Fundamentals, Network and security concept; Information assurance fundamentals, Basic cryptography, Symmetric encryption, Public key encryption, firewalls and virtualization.	15	1
UNIT II	Attacker technique and motivations; Using Proxies, Tunneling technique, Fraud technique, Rogue antivirus, Click fraud, Threat infrastructure, Exploitation; Shell code, Integer overflow, Stack based buffer overflows, String vulnerabilities, SQL injection, Malicious PDF file, Race condition, Web exploit tools, DoS condition.	20	2
UNIT III	Brute force and dictionary attacks, Cross site scripting, Social engineering, WarXing, Malicious code; self replicating malicious code, Evading detection and elevating privileges, Stealing information and exploitation, Memory forensics, Honeypots, Malicious code naming, Intrusion detection system	15	3
UNIT IV	Introduction to Cybersecurity law, Infamous cybercrimes, Cybercrime taxonomy, Civil vs criminal cybersecurity offenses, Basic element of criminal law, Branches of law, Tort law, Cyber	20	4



COM21E11 CYBER SECURITY AND CYBER LAWS

	law enforcement, Cybersecurity law jurisdiction, Cybercrime and cyber tort punishment.		
UNIT V	Cyber privacy and data protection law; Common law of privacy, Privacy laws, Data breach laws, Data breach litigation, Privacy notice law, Personal liability, Data disposal law, Cryptography and digital forensics law, Social media privacy, Future development in cybersecurity law.	14	5

Classroom	Mode of transaction								
Procedure	Direct Instruction: Brain storming lecture, Practical Session, 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 Mode of Assessment									
Types	A. Continuous Internal Assessment (CIA)								
	• Internal Tests – Minimum two (Extended answers / Practical)								
	• Seminar –								
	Research Literature review, Report writing, Presentation								
	• Assignments – Written, Practical, Oral presentation and viva								
	Case study/Mini project								
	B. Semester End Examination								



COM21E11 CYBER SECURITY AND CYBER LAWS

REFERENCES

- 1. James Graham, Rick Howard, Ryan Olson, Cyber Security Essentials, CRC Press, 2016.
- 2. MayankBhushan, Rajkumar Singh Rathore, AatifJamshed, Fundamentals of Cyber Security, BPB Publications, 2017.
- 3. TariSchreider, Cybersecurity Law, Standards and Regulations, 2nd Edition, Rothstein Publishing, 2020.
- 4. Information Resources Management Association, Cyber Law, Privacy, and Security Concepts, Methodologies, Tools, and Applications, IGI Global, 2019.
- 5. Jeff Kosseff, Cybersecurity Law, Wiley, 2019.



COM21E12 ADVANCED DATA STRUCTURES

Name of School	School of Cor	nputer Sc	iences			
Programme	M. Sc					
Name of Course	Advanced Da	ta Structur	res			
Type of Course	Elective					
Course Code	COM21E12					
Names of Academic Staff , Qualifications	Dr. Abdul Jab	Dr. Abdul Jabbar P, M Phil, PhD				
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	1					
Total Student Learning Time (SLT)	Learning Approach	Lectur e	Tutoria l	Practical	Others	Total Learnin g Hours
Pro roquicito	Explicit Teaching Seminar, Assignment s etc.	42	14	28	36	120
r re-requisite	The learner must have gained the fundamental concepts of Data Structure at bachelor level.					



COM21E12 ADVANCED DATA STRUCTURES

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.		
1	Define and develop data structure concept	A,An,S,E	3,4,6		
2	Construct and categorize various list such as linkedlists,	C,A,S ,E	4,5,8		
	Shared and Recursive Lists; Heterogeneous Lists -				
	Deterministic Skip Lists				
3	Expertise in Hashing technique using construct and	U,A,An,C	3,6,7,9		
	demonstrate Algorithms				
4	Identify a problem and analyze it in terms of its	A,An,S,E	3,4,6		
	significant parts and the information needed to solve				
	using Search Structures.				
5	Manage and develop Heap Structures in problem	A,C,An,E	4,8,9,10		
	solving aspects.				
6	Formulate and evaluate possible Algorithms of the	S,C,E	1,3,7,9		
	problems, and select and measure the chosen				
	Algorithms				
7	Demonstrate the ability to analyze, design, apply and	An,U,R,,A	5,6,7,8,9,1		
	use data structures and algorithms to solve engineering		0		
	problems and evaluate their solutions.				
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),					
Skill (S)					

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction to Data Structure: Overview, Types and Characteristics of Data Structure, Arrays, Stacks, Queues, Linked lists, Trees, Graphs.	15	1
UNIT II	Generalized linkedlists, 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

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21E12 ADVANCED DATA STRUCTURES

UNIT III	Search Structures, 2-3 Trees – 2-3-4 Trees Rd-Black Trees – B-Trees - Splay Trees – Digital Search Trees Tries – Differential Files – AA-Trees – Treaps – K Trees K-d Trees – Tries.	15	4
UNIT IV	Heap Structures, Min-Max Heaps – D-heaps – Leftist Heaps – Binomial Heaps – Fibonacci Heaps – Binary Heaps – Skew Heaps – Pairing Heaps – Applications.	20	5
UNIT V	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.	14	6,7

Classroom	Mode of transaction							
Procedure	Direct Instruction: Brain storming lecture, Practical Session, 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	Mode of Assessment							
Types	A. Continuous Internal Assessment (CIA)							
	6. Internal Tests – Minimum two (Extended answers / Practical)							
	7. Seminar –							
	 Research Literature review 							
	 Report writing 							
	 Presentation 							
	8. Assignments – Written, Practical, Oral presentation and viva							
	9. Case study/Mini project							
	B. Semester End Examination							



COM21E12 ADVANCED DATA STRUCTURES

REFERENCES

- 1. Ellis Horowitz, SartajSahni, 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. DebashishSamanta, 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, SartajSahni 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, YedidyahLangsam 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.



COM21E13 3D GRAPHICS

SchoolName	School of Computer Sciences								
Programme	M.Sc.								
Course Name	3D Graphics								
Type of Course	Elective								
Course Code	COM21E13								
Names of Academic Staff & Qualifications	Prof. Dr. Bindu V R, Ph.D								
Course Summary & Justification	Computer graphics is one of the vital aspects of any computing system. Its primary role is to render the digital content (0's and 1's) in a human-comprehensible form on the computer screen. The objective of this course is to familiarize students with fundamental algorithms and data structures that are used in today's interactive graphics systems as well as programming and architecture of high- resolution graphics computers. The students get hands on experience on graphic programming APIs such as OpenGL.								
Semester	1								
Total StudentLearningTim e (SLT)	Learning Approach	Lecture	Tutoria 1	Practica 1	Other s	Total Learnin g Hours			
	Explicit Teaching Seminar, Assignments etc.	42	14	28	36	120			
Pre-requisite	Basics of Geometry, linear algebra, vectors and matrices								


COM21E13 3D GRAPHICS

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.	
INO.		Domains		
1	Understand fundamentals of 3D graphics and display	U	1,2	
	methods			
2	Elucidate 3D Geometric transformations	U, An, E	1,2,10	
3	Analyze Representations of 3D Objects	An	1,3,5,10	
4	Illustrate representation of solids	U, A, An,	3,9,10	
		E		
5	Compare and Analyse Visible surface detection methods.	U, A, An	1,2,3,5,10	
6	Investigate types of projections and projection matrices	U, An, E	1,2,3,10	
7	Create graphic programs using OpenGL	U, An, A,	1,2,3,5,10	
		С, Е		
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),				
Skill (S				

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction - Three dimensional Concepts, Display Methods	8	1
UNIT II	3D Geometric transformations- Translation, Scaling, Rotation, Reflection, Shear, Composite Transformations, Modeling and Co-ordinate transformations	20	2
UNIT III	Representations of 3D Objects - Polygon surfaces, Representation of curves and surfaces, Representing solids- Sweep representations, Boundary representations, Spatial-partitioning representations, Constructive solid geometry.Visible surface detection methods. Shading and Illumination.	24	3,4,5
UNIT IV	Viewing-Projections, ProjectionMatrices.	16	6
UNIT V	Discrete Techniques in OpenGL - Texture mapping, Bit and Pixel operations, Compositing, Sampling and Aliasing Techniques.	16	7

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21E13 3D GRAPHICS

Teaching	Classroom Procedure (Mode of transaction)					
andLearningApproac h	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					
	A. Continuous Internal Assessment (CIA)					
	• Internal Tests – Minimum two (Extended answers)					
	• Seminar –					
	Research Literature review					
	 Report writing 					
	 Presentation 					
	• Assignments – Written, Oral presentation and viva					
	• Case study					
	B. Semester End Examination					



COM21E13 3D GRAPHICS

- 1. Hearn D., Baker M, P., Computer Graphics, Prentice-Hall of India.
- Foley J,D.,Andries Van Dam, Computer Graphics Principles and Practice, Addison-Wesley.
- **3.** Angel, Edward. Interactive Computer Graphics- A Top-down Approach with OpenGL, Addison-Wesley.
- 4. F. S. Hill, Computer Graphics Using OpenGL, Pearson Education.
- 5. Alan Watt, 3D Computer graphics, Pearson Education.



COM21C21 MACHINE LEARNING

SECOND SEMESTER

School Name	School of Computer Sciences					
Programme	M. Sc.					
Course Name	Machine Lear	ning				
Type of Course	Core					
Course Code	COM21C21					
Names of Academic Staff & Qualifications	Prof. (Dr.) Anuj Mohamed, Ph. D.					
Course Summary & Justification	This course provides knowledge of techniques to design efficient machine learning algorithms to solve real-world problems. The students will learn the basic mathematical/statistical concepts required to understand and develop machine learning algorithms. The students will also get acquainted with the design and implementation of efficient algorithms to solve various real-life problems by applying the neural network approach					
Semester	II	1, 6		.		
Total StudentLearningTim e (SLT)	Learning Approach	Lectur e	Tutorial	Practica 1	Other s	Total Learning Hours
	Explicit Teaching Seminar, Assignments, etc.	42	14	28	36	120
Pre-requisite	Mathematical H	Foundatio	ons, Program	nming Skil	ls	



COM21C21 MACHINE LEARNING

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.
No.		Domains	
1	Understand the concept of machine learning and its	U, A	1,3
	applications.		
2	Understand and apply mathematical/statistical concepts	U, A, An	2, 3,4
	required to develop efficient machine learning		
	algorithms.		
3	Understand and apply the Bayesian method	U, A, An	1, 2, 3
4	Understand the concept and various techniques for	U	1
_	prediction		
5	Understand and apply the concept of linear regression to	U, An, A,	1,2,3,4
	solve prediction problems	C	1.0
6	Understand and apply the concept of the gradient descent	U, A	1,2
	approach	T T	1
/	Understand the concept and various techniques for	U	1
0			1024
8	Understand and apply the concept of logistic regression	U, An, A,	1,2,3,4
0	to solve classification problems		1228
9	Apply the concept of regularization in linear and logistic	U,AII,A,E	1,2,3,8
10	Independent of Artificial Neural Networks	II A An C	1225
10	Multilayer Percentrons and apply the Backpropagation	U,A,All, C	1,2,3,3
	algorithm for training the neural network		
11	Critically analyze the efficiency of alternative	II An F	128
	algorithmic solutions for the same problem	0,711, L	1,2,0
12	Design and implement efficient algorithms to solve	U. A. An.	1.2.3.5.8
	various real-life problems by applying neural network	C.E	1,2,0,0,0
	concepts and presenting the approach effectively with	- 7	
	appropriate tools.		
13	Acquire knowledge and skills through self-paced and	U, An, A,	7, 8, 10
	self-directed learning and adapt to changing trends	C, E	
	through knowledge/skill updation/reskilling.		
*Roma	mhar (B) Understand (U) Annhy (A) Analyse (An) Eval	Lato (E) Croa	$t_{\alpha}(C)$
Skill / S	mber (K), Unuersiana (U), Appiy (A), Anaiyse (An), Evau N	iuie (E), Cred	ie (C),
DNIII (D	77		



COM21C21 MACHINE LEARNING

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction: Concept of Machine Learning, Types of Machine Learning, Challenges of Machine Learning, Applications of Machine Learning, Mathematical Foundations for Machine Learning: Linear Algebra, Analytic Geometry, Matrix Decompositions, Vector Calculus, Probability and Distributions, Continuous Optimization, Statistical Learning: Bayesian Method, The Naive Bayes Classifier.	20	1,2,3,13
UNIT II	Linear Regression: Prediction using Linear Regression, Gradient Descent, Linear Regression with one Variable, Linear Regression with Multiple Variables, Polynomial Regression, Feature Scaling/Selection.	14	4,5,13
UNIT III	Logistic Regression: Classification using Logistic Regression, Logistic Regression vs. Linear Regression, Logistic Regression with one Variable and with Multiple Variables.	14	6,7,8,9,13
UNITI V	Regularization: Regularization and its Utility: The problem of Overfitting, Application of Regularization in Linear and Logistic Regression, Regularization and Bias/Variance.	14	11,13
UNIT V	Neural Networks: Introduction, Model Representation, Gradient Descent vs. Perceptron Training, Stochastic Gradient Descent, Multilayer Perceptrons, Multiclass Representation, Back Propagation Algorithm.	22	6,10,12,1 3



COM21C21 MACHINE LEARNING

Teaching and	Classroom Procedure (Mode of transaction)					
Learning	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning,					
Approach	Interactive Instruction: Active co-operative learning, Seminar, Group Assignments					
	Authentic learning: Library work and Group discussion, Presentation by					
	individual student/Group representative.					
Assessment	Mode of Assessment					
Types	A. Continuous Internal Assessment (CIA)					
	• Internal Tests – Minimum two (Extended answers / Practical)					
	• Seminar –					
	 Research Literature review 					
	 Report writing 					
	 Presentation 					
	• Assignments – Written, Practical, Oral presentation and viva					
	• Case study/Mini project					
	B. Semester End Examination					

- 1. EthemAlpaydin, "Introduction to Machine Learning", 4th Edition, The MIT Press.
- 2. Deisenroth, Marc Peter, et al. Mathematics for Machine Learning. Cambridge University Press.
- 3. Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning with Applications in R, Second Edition, Springer.
- 4. Christopher M. Bishop, "Pattern Recognition and Machine Learning".
- 5. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press.
- 6. Kevin P. Murphy, "Machine Learning, 2nd Edition, The MIT Press.
- 7. Dipanjan Sarkar, Raghav Bali, Tushar Sharma, Practical Machine Learning with Python, Apress
- 8. Yegnanarayana B, Artificial Neural Networks, Prentice-Hall India Pvt. Ltd.
- 9. "Mastering Machine Learning: A Step-by-Step Guide with MATLAB", MathWorks.
- 10. Giuseppe Ciaburro, "MATLAB for Machine Learning", Packt Publishing Limited.
- 11. U Dinesh Kumar, Manaranjan Pradhan, "Machine Learning using Python", Wiley.
- 12. Tom M. Mitchell, "Machine Learning", 1st Edition, Tata McGraw-Hill Education.



COM21C22 DIGITAL IMAGE PROCESSING

School Name	School of Com	School of Computer Sciences					
Programme	M. Sc.	M. Sc.					
Course Name	Digital Image	Processin	g				
Type of Course	Core						
Course Code	COM21C22						
Names of Academic Staff & Qualifications	Prof. Dr. Bindu V R, M. Sc., Ph. D.						
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	11	1			1		
Total StudentLearningTim e (SLT)	Learning Approach	Lectur e	Tutoria 1	Practica 1	Others	Total Learning Hours	
Pre-requisite	Explicit Teaching Seminar, Assignment, case Study etc. Overview of Co	0 42	28 ystem and	42 basic math	8 nematics.	120	
Pre-requisite	Overview of Co	omputer S	ystem and	basic math	nematics.		



COM21C22 DIGITAL IMAGE PROCESSING

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Define the elements of image processing and differentiate color image models in image representation.	U, An	1
2	Compare and Analyse various spatial domain and frequency domain image transformations and filtering techniques.	An	1,2
3	Analyse and Compare various image enhancement techniques.	An	1,2,4
4	Illustrate histogram processing on an image.	A, An	1,2,3
5	Analyse and Compare various image restoration	An	
	techniques.		1,2,4
6	Illustrate different morphological operations on an image.	A, An	1,2,3
7	Analyse and Compare various image segmentation techniques.	An	1.2.4
8	Illustrate segmentation of an image.	A, An	1.2.3
9	Develop programs implementing the different image	U. A	1,2,3,4
	processing operations on sample images and illustrate.	,	
10	Discuss image recognition techniques.	U, An	1,2
11	Analyse and compare the methods for image compression.	An	1,2,4
12	Discuss, analyse and compare the latest technologies and	U, An, A,	5, 7, 8, 9,
	issues in Digital Image Processing.	C, E	10
*Reme Skill (S	mber (R), Understand (U), Apply (A), Analyse (An), Evalu ()	iate (E), Crea	te (\overline{C}),



COM21C22 DIGITAL IMAGE PROCESSING

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO
			No.
UNIT I	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.	20	1
UNIT II	Image Transforms- 1D DFT, 2D transforms – DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD, Radon and Wavelet Transform.	22	2,12
UNIT III	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.	24	2,3,4,5, 12
UNIT IV	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.	24	6,7,8,1 0,12
UNIT V	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.	22	9,11,12



COM21C22 DIGITAL IMAGE PROCESSING

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,					
	individual student/ Group representative					
Assessment Types	Mode of Assessment A. Continuous Internal Assessment (CIA)					
	 Internal Tests – Minimum Two (Extended answers / Practical) 					
	• Seminar –					
	 Research Literature Review 					
	 Report Writing 					
	 Presentation 					
	• Assignment – Written, Practical, Oral Presentation and Viva					
	 Case study/ Mini project B. Semester End Examination 					

- 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 York Inc.
- **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.



COM21C23 DATA MINING

SchoolName	School of Computer Sciences						
Programme	M. Sc.						
Course Name	Data Mining	Data Mining					
Type of Course	Core						
Course Code	COM21C23						
Names of Academic Staff & Qualifications	Prof. Dr. Pushpalatha K P, MCA, PhD						
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. The students will be able to acquire a very broad yet in-depth knowledge and practice of the principles of data mining and data mining techniques after studying this course. It will help to improve their knowledge and intelligence in decision making process and enable them to be capable of handling jobs in R & D divisions of						
Semester	II						
Total StudentLearningTim e (SLT)	Learning Approach	Lecture	Tutoria 1	Practica 1	Other s	Total Learning Hours	
	Explicit Teaching Seminar, Assignments etc.4228428120						
Pre-requisite	Understanding i	in Databas	e Managei	ment and St	tatistics		



COM21C23 DATA MINING

COURSE OUTCOMES (CO)

CO No	Expected Course Outcome	Learning	PSO No.
1NO.	I have a state of the second second in a state of the second seco	Domains	2
1	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 functionalities and analyse the performance of the algorithms to select the best.	A, An, C	2, 5, 8, 10
5	Demonstrate the benefits of various visualisation tools.	R, U, E	1, 2, 3, 5, 10
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, 10
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, 10
*Reme	mber (R), Understand (U), Apply (A), Analyse (An), Evalu	uate (E), Crea	te (C),
Skill (S	5)		



COM21C23 DATA MINING

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction to Data Mining, Data Mining Functionalities, Classification of Data Mining Systems, Major Issues in Data Mining, Basic Concepts of Data Warehouse, Multitired 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.	20	1,2,12
UNIT II	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. Needs 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.	24	1,5,12
UNIT III	Mining Frequent Patterns, Associations and Correlations: Basic Concepts, Frequent Itemset Mining Methods, Apriori Algorithm, Mining Frequent Itemsets Using Vertical Data Formats, Generating Association Rules, Strong Rules and Weak Rules.	20	3,4,8,12
UNIT IV	Introduction to Classification, Classification by Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Naïve Bayesian Classification, Concepts of : Classification by Back propagation, Lazy Learners, k- Nearest Neighbor Classifiers, An Overview of Other	24	3,7,8,9,1 2



COM21C23 DATA MINING

	Classification Methods, Genetic, Fuzzy Sets, Model Evaluation and Selection, Haldout Method, Cross Validation, Boot Strap.		
UNIT V	Introduction to Cluster Analysis, An Overview of Major Clustering Methods, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Probabilistic Model- Based Methods, Expectation-Maximisation Algorithm, Outlier Detection, Outlier Detection Methods, Introduction to Spatio-temporal Data Mining, Multimedia Data Mining, Text Mining, Mining the World Wide Web.	24	3,8,10,1, 12

Teaching and	Classroom Procedure (Mode of transaction)						
Learning	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning,						
Approach	Interactive Instruction: Active co-operative learning, Seminar, Group						
	Assignments						
	Authentic learning: Library work and Group discussion, Presentation by						
	individual student/Group representative.						
Assessment	Mode of Assessment						
Types	A. Continuous Internal Assessment (CIA)						
	• Internal Tests – Minimum two (Extended answers / Practical)						
	• Seminar –						
	 Research Literature review 						
	 Report writing 						
	 Presentation 						
	• Assignments – Written, Practical, Oral presentation and viva						
	• Case study						
	B. End Semester Examination						
	 Research Literature review Report writing Presentation Assignments – Written, Practical, Oral presentation and viva Case study B. End Semester Examination						



COM21C23 DATA MINING

- **1.** Data Mining Concepts and Techniques JIAWEI HAN & MICHELINE KAMBER,ELSEVIER,3rd Edition.
- 2. MehmedKantardzic, 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



COM21C24 SOFTWARE ENGINEERING

Name of School	School of Comput	er Science	es			
Programme	M. Sc	M. Sc				
Name of Course	Software Engine	ering				
Type of Course	Core					
Course Code	COM21C24					
Names of Academic Staff & Qualifications	Dr. Abdul Jabbar	P, M Phil	, PhD			
Course Summary & Justification	The course covers the theoretical concept of the design, analysis, and implementation of software development process. Areas include software requirement engineering, Process Models, Object oriented design concepts, Project management concept and solving real world practical problems. This course gives awareness on information Ethics that must be kept throughout the software development process. This course is very important in terms of employability of the students. The Course focuses on software research and development job opportunities in the industries such as Software consultant, Software Designer, Software Testing, Software Developer, Project Manager, SEO, Software Marketing and programmer					
Semester	II	0				
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutoria 1	Practical	Others	Total Learning Hours
	Direct Teaching Seminar, Assignments, Self Learning etc.	42		28	50	120
Pre-requisite	The learner must have gained the fundamental concepts of software.					



COM21C24 SOFTWARE ENGINEERING

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.		
1	Practice on Information Ethics and Software Engineering	I,R,U	1,2,10		
2	Understand and formulate Software Requirement Engineering	A,An,S,E	3,4,5		
3	Expertise in Object Oriented Software Design	C,A,I,S ,E	3,4,5		
4	Identify design problem and analyze Software Quality Assurance	U,A,An,C,A t	3,4,5 ,8		
5	Manage and develop Software using software project management	A,C,An,E	3,4		
6	Formulate and evaluate possible software development process models in advance level	Ap,S,C,E	5,6,7, 3,4		
7	Demonstrate the ability to analyze, design, apply and	U,Ap,R,I, At	5,6,7,8,9,1		
	use of software requirement engineering and quality	,Ap	0		
	assurance in software project				
*Reme	*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),				
Skill (S	Y).				

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Information and Computer Ethics, Software and Software Engineering, Software Development Process Models – The Waterfall Model, V-Model, Incremental Process Models, Prototyping, Spiral Model, Concurrent Models. Agile Development, Principles that Guide Practice.	10	1,6
UNIT II	Understanding Requirements, Requirements Modeling: Scenarios, Information, and Analysis Classes, Requirements Modeling for WebApps, Design Concepts, Software Architecture: Definition, Importance and Styles, User Interface Design.	15	2,7



COM21C24 SOFTWARE ENGINEERING

UNIT III	Object Oriented Software Design using UML, Class Diagram, Deployment Diagram, Use case Diagram, Sequence Diagram, Communication Diagram, Activity Diagram, State Diagram.	15	3
UNIT IV	Quality Concepts, Review Techniques, Software Quality Assurance, Software Configuration Management, Product Metrics, Software Testing Strategies, Testing Conventional Applications, Testing Object-Oriented Applications, Testing Web Applications.	15	4,7
UNIT V	Project Management Concepts, Process and Project Metrics, Estimation for Software Projects, Project Scheduling, Risk Management. Searching and Application.	15	5

Teaching and Learning Approach	Classroom 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	Mode of Assessment					
Types	A. Continuous Internal Assessment (CIA)					
	• Internal Tests – Minimum two (Extended answers / Practical)					
	• Seminar –					
	Research Literature review					
	Report writing					
	 Presentation 					
	• Assignments – Written, Practical, Oral presentation and viva					
	• Case study					
	B. End Semester Examination					



COM21C24 SOFTWARE ENGINEERING

- 1. Pressman, R.S., Software Engineering: A Practitioner's Approach, MGHISE, 7th Edition.
- 2. Bernd Bruegg and Allen H, Object Oriented Software Engineering Using UML, Patterns and Java, 2ndEditio.
- 3. Rajib Mall, Fundamentals of Software Engineering,4th Edition, PHI.
- 4. AnirbanBasu, Software Quality Assurance, Testing and Metrics, First Edition, PHI
- 5. Sommerville, I., Software Engineering, Pearson Education, 7th Ed..
- 6. Schach, S., Software Engineering, TMH, 7th Ed..
- 7. Kelkar, S.A., Software Engineering: A Concise Study, PHI.
- 8. Hughes, B and Cotterel, M., Software Project Management, 3rd Edition, TMH.
- 9. Kenneth E. Himma, The Handbook of Information and Computer Ethics, Wiley.



COM21C25 MINOR PROJECT USING ADVANCED JAVA & OBJECT ORIENTED ANALYSIS AND DESIGN-LAB

School Name	School of Computer Sciences					
Programme	M.Sc.					
Course Name	Minor Project usi Design-Lab	Minor Project using Advanced Java & Object Oriented Analysis and Design-Lab				
Type of Course	Core					
Course Code	COM21C25					
Names of Academic Staff & Qualifications	Dr. Ivy Prathap P	h.D.				
Course Summary & Justification	This course aims to develop a minor software project based on software engineering and object oriented concepts using Advanced Java. This course gives awareness and prompt them to keep-up the software development ethics. It enables the students to avail jobs such as software engineers (in general) and web applications developers.					
Semester	II	II				
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutoria 1	Pract ical	Others	Total Learning Hours
	Explicit Teaching		14	84		
	Assignments, Viva, Record Preparation etc.				22	120
Pre-requisite	Core Java					



COM21C25 MINOR PROJECT USING ADVANCED JAVA & OBJECT ORIENTED ANALYSIS AND DESIGN-LAB

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.
No.		Domains	
1	Prepare SRS, DFD, Activity diagram	U, C	1,2.3
2	Develop skill to prepare UML, Class Diagram,	U,R, A, C,	1,2,3,4,
	Deployment Diagram, Use case Diagram, Sequence	S	7,10
	Diagram, Communication Diagram, Activity Diagram		
	and State Diagram.		
3	Write, test and debug Java programs using Remote	A, An	1,2,3
	Method Invocation		
4	Familiarize with Servlet Form Processing using Java	U, R	1,2,3
5	Apply session management to real world problems.	A, C	1,2,3,4,7
			10
6	Illustrate the uses of Using Database with JSP	А	1,2,3,4
7	Discover the capabilities of Struts ad Hibernate	S, C, E	1,2,3,4,7,1
			0
8	Interpret the concepts of Spring framework	An, E	1,2,3,4,7,1
			0
9	Develop programs using Springboot	C, A	1,2,3,4,
			7,10
10	Achieve skill to develop web applications using Java	S, C	1,2,3,4,
			7,10
*Reme	mber (R), Understand (U), Apply (A), Analyse (An), Eva	luate (E), Cre	ate (C),
Skill (S			

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Software Engineering Concepts, Software and Software Engineering, Software Development Process Models – The Waterfall Model, V-Model, Incremental Process Models, Prototyping, Spiral Model, Concurrent Models. Software Implementation and Management process- inspection, Agile Development, Principles that Guide Practice. Object Oriented Programming Concepts, Object Oriented Software Design using UML, Class Diagram, Deployment Diagram, Use case Diagram, Sequence Diagram, Communication Diagram, Activity Diagram and State Diagram.	20	1,2

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21C25 MINOR PROJECT USING ADVANCED JAVA & OBJECT ORIENTED ANALYSIS AND DESIGN-LAB

UNIT II	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. Java Servlets: Servlet Overview, Basic Servlet Architecture, Servlet Form Processing, Session Management, Database Management Using Servlets.	15	3,4,5
UNIT III	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	6
UNIT IV	Distributed Applications and Components: J2EE architecture, Enterprise Java Beans (EJB) - Application Servers-Types of Bean - Session Bean, Entity Bean and Message Driven Bean.	23	5
UNIT V	Struts and Hibernate: Overview of MVC Design, Struts, Components, Configuration files-Introduction to Hibernate, Hibernate Application, Hibernate Object Life Cycle. Spring framework: Spring Modules, Inversion of Control and Dependency injection, Web Services: SOAP, RESTful. Introduction to Springboot.	20	7,8,9, 10

Teaching and	Classroom Procedure (Mode of transaction)
Learning	Explicit Teaching, E-learning, Active co-operative learning, Inquiry-based
Approach	instruction, Authentic learning, Library work and Group discussions
Assessment	Mode of Assessment
Types	
	A. Continuous Internal Assessment (CIA)
	• Technical skills evaluation - Correctness of programs
	• Internal Tests – Minimum two (Practical)
	 Assignments -Lab Records, Practical and Viva
	• Case study
	B. Semester End Examination



COM21C25 MINOR PROJECT USING ADVANCED JAVA & OBJECT ORIENTED ANALYSIS AND DESIGN-LAB

- **1.** Budi Kurniawan, Sams, Java for the Web with Servlets, JSP, and EJB: A Developer's Guide to Scalable J2EE Solutions.
- 2. Karl Avedal, Professional JSP, Wrox Press, Second Edition.
- **3.** James Holmes, The Complete Reference to Struts, Tata McGraw-Hill, Second Edition.
- 4. Jeff Linwood, .Dave Minter, Beginning to Hibernate, Second Edition
- 5. <u>Rod Johnson, JuergenHoeller, AlefArendsen, Thomas R</u>, Professional Java Development with the Spring Framework, Wiley India Pvt. Ltd..
- 6. <u>Greg L. Turnquist</u>, Learning Spring Boot, Packt Publishing.
- 7. https://tomcat.apache.org/
- 8. <u>https://olemiss.edu/projects/servlets/</u>
- 9. <u>https://spring.io/</u>



COM21E21 WIRELESS COMMUNICATION AND SENSOR NETWORKS

ELECTIVES

School Name	School of Con	nputer Scie	ences			
Programme	M.Sc.					
Course Name	Wireless Com	municatio	n and Sen	sor Netwo	rks	
Type of Course	Elective					
Course Code	COM21E21					
Names of Academic Staff & Qualifications	Dr. Ivy Prathar	o, Ph.D.				
Course Summary & Justification	Telecommunic wires, cables of distance or acro concept, gene networks, Rou	ation invol or any othe oss the glob rations of ting protoco	ves transm er electric e. This cou Cellular ols used ar	nission of al conducto urse introdu communic ad Quality of	informations within the withing the second second the second seco	ion without n a shorter s of cellular dhoc/sensor e.
Semester	II	01				
Total StudentLearningTim e (SLT)	Learning Approach	Lecture	Tutoria 1	Practica 1	Other s	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	36	120
Pre-requisite	Basics of Data	Communic	cation			



COM21E21 WIRELESS COMMUNICATION AND SENSOR NETWORKS

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand fundamentals of Wireless communication System	U	1,2,10
2	Elucidate generation of Cellular Networks	Е	2,10
3	Analyze various types of Channel Assignment Strategies	An	3,10
4	Understand adhoc/sensor networks		
5	Illustrate issues in adhoc wireless networks	А	3,9,10
6	Examine MAC protocols for adhoc wireless networks	А	1,10
7	Investigate the role of Routing Protocols for sensor network, location discovery, quality and other issues	Е	2,10
8	Apply Quality of Service in energy management	А	1,9,10
* <i>Reme</i> (S)	mber (R), Understand (U), Apply (A), Analyse (An), Evalu	ate (E), Creat	e (C), Skill

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	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
UNIT II	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



COM21E21 WIRELESS COMMUNICATION AND SENSOR NETWORKS

UNIT III	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.	17	4,5,6,7
UNIT IV	Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.	15	8
UNIT V	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

Teaching and	Classroom Procedure (Mode of transaction)
Learning	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning,
Approach	Interactive Instruction: Active co-operative learning, Seminar, Group
	Assignments
	Authentic learning: Library work and Group discussion, Presentation by
	individual student/Group representative.
Assessment	Mode of Assessment
Types	A. Continuous Internal Assessment (CIA)
	• Internal Tests – Minimum two (Extended answers)
	• Seminar –
	 Research Literature review
	 Report writing
	 Presentation
	• Assignments – Written, Oral presentation and viva
	• Case study
	B. Semester End Examination



COM21E21 WIRELESS COMMUNICATION AND SENSOR NETWORKS

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



COM21E22 CYBER PHYSICAL SYSTEMS

Name of School	School of Computer Sciences					
Programme	M. Sc					
Name of Course	Cyber Physica	l Systems				
Type of Course	Elective	Elective				
Course Code	COM21E22					
Names of Academic Staff & Qualifications	Dr. Abdul Jabb	ar P, MPhil,	PhD			
Course Summary & Justification	The course covers the advanced concept of the cyber physical system. The topic covered data harvesting, various cps controls and security challenges.					
Semester	II	-				
Total StudentLearningTim e (SLT)	Learning Approach	Lecture	Tutoria 1	Practical	Others	Total
	Direct Teaching Assignments, Seminar, self study	42	14	28	36	120
Pre-requisite	The learner m Networking	nust have g	gained the	fundamen	ntal conce	epts of



COM21E22 CYBER PHYSICAL SYSTEMS

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.	
1	Identify the importance of cross domain analysis and adaptive control of cyber physical system.	A,R,U	1,2,10	
2	Analysis and verify various distributed consensus control for wireless CPS and communication channels of multi agent system.	A,An,S,E	3,4,5	
3	Understand various CPS Control in online and optimization of CPS.	A,S ,E	2,3,4	
4	Analyse and evaluate 5G MTS architecture and communication of industrial CPS	An,C,E ,A	3,4,5	
5	Manage and develop cyber physical system Formulate challenges in research.	A,C,An,E	3,4,5	
6	Formulate and evaluate reliable Cyber system to manage data and communication	S,C,E	1,3,4,6	
7	Demonstrate the ability to analyze, design, apply and create Cyber Physical System	U,A,R,C	5,6,7,8,9,1 0	
*Remen Skill (S	*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO
			No.
	Introduction to CPS; Characteristics of CPS, CPS Domains,		1,2,7
UNIT I	Cross-Domain Analysis, Adaptive control in CPS.	15	
UNIT II	Distributed Consensus control for wireless CPS, Communication		2,7
	channels of multi agent system, Consensus control, Interaction control theory, Distributed control, Adaptive Quantization, Transmission length.	20	
	Online control and optimization of CPS, Framework, IPA, Data		2,3,7
UNIT III	harvesting problems, Direct RF energy harvesting, Relayed RF energy harvesting.	15	



COM21E22 CYBER PHYSICAL SYSTEMS

UNIT IV	Industrial CPS, Communication in 5G MTS, Challenges and research trends, Network architecture for MTC, RA for MTC.	20	4,6,7
UNIT V	Data reliability challenge, Network wide programming challenges, CPS and human action, Security and privacy of CPS, Validation Verification and formal methods of CPS.	14	5,6,7

Teaching and	Classroom Procedure - Mode of transaction		
Learning	Direct Instruction: Brain storming lecture, Practical Session, Explicit		
Approach	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	Mode of Assessment		
Types	A. Continuous Internal Assessment (CIA)		
	10. Internal Tests – Minimum two (Extended answers / Practical)		
	11. Seminar –		
	 Research Literature review 		
	 Report writing 		
	 Presentation 		
	12. Assignments – Written, Practical, Oral presentation and viva		
	13.Case study/Mini project		
	B. Semester End Examination		

- 1. Danda B. Rawat, Sabina Jeschke, Christian Brecher, Cyber-Physical Systems Foundations, Principles and Applications, Elsevier Science.
- 2. Glenn A. Fink, Sabina Jeschke, Security and Privacy in Cyber-Physical Systems Foundations, Principles, and Applications, Wiley.
- 3. Walid M. Taha, Abd-Elhamid M. Taha, Johan Thunberg, Cyber-Physical Systems: A Model-Based Approach, Springer International Publishing.



COM21E23 DISTRIBUTED SYSTEMS AND PARALLEL COMPUTING

Name of School	School of Computer Sciences					
Programme	M. Sc					
Name of Course	Distributed Systems and Parallel Computing					
Type of Course	Elective					
Course Code	COM21E23					
Names of Academic Staff & Qualifications	Dr. Abdul Jabbar P, MPhil, PhD					
Course Summary & Justification	The course covers the advanced concept of the distributed system, cloud environment and distributed data management.					
Semester	П					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total
()	Direct teaching:	42	14	28		120
	Seminar, Assignment, Self learning				36	
Pre-requisite	The learner must have gained the fundamental concepts of Distributed System					



COM21E23 DISTRIBUTED SYSTEMS AND PARALLEL COMPUTING

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.	
1	Recognize the architectural models, features and challenges of Distributed Systems.	A,R,U	1,2,5	
2	Demonstrate and evaluate the various distributed objects communication and algorithm.	A,An,S,E	1,3,4,5	
3	Exploration of characteristics and features of distributed computing in various cloud environment.	A,S ,E	2,3,4	
4	Compare and analysis the parallel computing models, laws and theorems and parallel computation complexity.	An,C,E	3,4,5	
5	Manage and demonstrate basic file operating system and Hadoop file system and data using HDFs.	A,C,An,E	3,4,5	
6	Illustrate the applications of distributed system and parallel computing-Role to manage data.	S,C,E	1,3,4,6	
7	Demonstrate the ability to design, apply and analyze distributed system and data.	U,R,An,A	5,6,7,8,9,1 0	
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)				

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO
			No.
	Characterization of distributed systems: Introduction, Examples of		1,7
UNIT I	Distributed Systems, Resource sharing and the Web, Challenges,	15	
	Architectural models, Fundamental models, Networking issues.		
UNIT II	Distributed Objects and Remote Invocation: Communication		2,7
	between Distributed Objects, Remote Procedure Call, Remote		
	Method Invocation, Request Reply Protocol. Overview of	20	
	Distributed Mutual Exclusion-Central Server Algorithm and Ring-		
	Based Algorithm, Elections-Ring based Election Algorithm.		
UNIT III	Distributed Computing and Cloud Computing, introduction,		3,7
	Characteristics, Difference, History of Cloud Computing and	15	
	Distributed Computing, Pros and cons, Security.		

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21E23 DISTRIBUTED SYSTEMS AND PARALLEL COMPUTING

UNIT IV	Overview of Parallel Systems, Modeling Parallel Computation, Micro-Processor Models, Parallel Computation Complexity, Laws and Theorems of Parallel Computation, OpenCL for Massively Parallel Processors.	20	4,5,7
UNIT V	Introduction to Hadoop, Data, Data Storage and Analysis, MapReduce: Weather Dataset, Analyzing with Unix Tool, Scaling Out, Hadoop Streaming, Hadoop Pipes. Design of HDFS, Blocks, Namenodes and datanodes, Command line Interface, Basic File system Operation, Hadoop file system, Interfaces, Reading data from Hadoop URL, Reading data from FileSystem API, writing data.	14	5,6,7

Teaching and	Classroom Procedure - Mode of transaction				
Learning	Direct Instruction: Brain storming lecture, Practical Session, Explicit Teaching,				
Approach	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	Mode of Assessment				
Types	A. Continuous Internal Assessment (CIA)				
	14. Internal Tests – Minimum two (Extended answers / Practical)				
	15. Seminar –				
	 Research Literature review 				
	 Report writing 				
	 Presentation 				
	16. Assignments – Written, Practical, Oral presentation and viva				
	17. Case study/Mini project				
	B. Semester End Examination				



COM21E23 DISTRIBUTED SYSTEMS AND PARALLEL COMPUTING

- 1. George Coulouris, Jean Dollimore, Tim Kindberg, Distributed Systems: Concepts and Design, Pearson Education Asia, 5th Edition.
- Tanenbaum Andrew S. and Steen Maarten Van, Distributed Systems: Principles and Paradigms, 2nd Edition.
- 3. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH.
- 4. Ronald L. Krutz, Russell Dean Vines, "Cloud Security A comprehensive Guide to Secure Cloud Computing", Wiley India.
- 5. M.N Rao, Cloud Computing, First Edition, PHI.
- 6. Das Gupta, Cloud Computing Based Projects using distributed Architecture, PHI.
- 7. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers.
- 8. Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, Augus.
- 9. Tom White, Hadoop: The Definitive Guide, OReilly Media



COM21C31 THEORETICAL COMPUTER SCIENCE

THIRD SEMESTER

School Name	School of Computer Sciences					
Programme	M.Sc.					
Course Name	Theoretical Computer Science					
Type of Course	Core					
Course Code	COM21C31					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose, M.Tech					
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	III					
Total StudentLearningTim e (SLT)	Learning Approach	Lectur e	Tutoria 1	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	28		38	120
Pre-requisite	Discrete Mathematics, Data Structures and Algorithms					


COM21C31 THEORETICAL COMPUTER SCIENCE

COURSE OUTCOMES (CO)

СО	Expected Course Outcome	Learning	PSO No.		
No.		Domains			
1	Formalize the notion of computation using "abstract	U, An,A	1,2,3		
	computing devices" called automata				
2	Understand the hierarchy of classes of automata: finite	U,An	2,3,10		
	automata, pushdown automata, linear bounded automata,				
	and Turing machines				
3	Formalize the notion of problems via formal languages	U,A,An,E	1,2,3,8		
	and classify them into regular, context-free, context				
	sensitive and unrestricted languages.				
4	Design finite state automata, regular grammar and	A,An, C	1,2,3		
	regular expression for regular languages.				
5	Design push-down automata and context-free grammar	A,An,,C	1,2,3		
	representations for context-free languages.				
6	Design Turing Machines for accepting recursively	A,An,,C	1,2,3		
	enumerable languages				
7	Understand the concepts of undecidability, intractable	U,E	2,8		
	problems, DNA computing and membrane computing.				
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),					
Skill (S	5)				

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No
			110.
UNIT I	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
UNIT II	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.	16	2
UNIT III	Context-Free Grammars and Languages: Context-Free Grammars, Parse Trees, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages.	14	2,3,4

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21C31 THEORETICAL COMPUTER SCIENCE

UNIT IV	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.	14	2,3,4, 5
UNIT V	Turing Machines: The Turing Machine, Programming Techniques for Turing Machines, Turing Machines and Computers. Introduction to: Undecidability, Intractable Problems, DNA Computing, Membrane Computing.	12	2,3.6, 7

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Direct Instruction: 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	Mode of Assessment					
Types	A. Continuous Internal Assessment (CIA)					
	• Internal Tests – Minimum two (Extended answers)					
	• Seminar –					
	 Research Literature review 					
	 Report writing 					
	 Presentation 					
	• Assignments – Written, Oral presentation and viva.					
	• Case study					
	B. Semester End Examination					



COM21C31 THEORETICAL COMPUTER SCIENCE

- 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.



COM21C32 DEEP LEARNING

School Name	School of Compu	iter Scien	ces				
Programme	M.Sc.						
Course Name	Deep Learning						
Type of Course	Core						
Course Code	COM21C32						
Names of Academic Staff & Qualifications	Prof. (Dr.) Anuj	Mohamed,	Ph D				
Course Summary & Justification	This course aims learning, includin relevant learning a the design and im real-life applicat processing to m advanced deep lea	This course aims to provide foundations of machine learning and deep learning, including the ability to successfully implement, apply and test relevant learning algorithms. The students will also get acquainted with the design and implementation of efficient algorithms to solve various real-life applications ranging from speech and natural language processing to machine vision and medical imaging by applying advanced deep learning technologies					
Semester	III						
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutoria 1	Pract ical	Others	Total Learning Hours	
	Explicit Teaching	42	28	14		120	
	Seminar etc.				36	120	
Pre-requisite	Machine Learning	g & Neural	l Networks	6			



COM21C32 DEEP LEARNING

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.
No.		Domains	
1	Understand the concept of machine learning and its	U, A	1,3
	applications.		
2	Understand and apply gradient-descent techniques to	U,An,A,E	1,2,3,8
	train deep neural networks.		
3	Understand and apply generalization strategies	U, An, A	1,2,3
4	Understand and apply various Optimization techniques	U, An, A	1,2,3
	for training deep models		
5	Construct and train convolutional and recurrent neural	U,An,A,E	1,2,3,8
	networks.		
6	Understand the apply the concept of Auto encoders and	U, An, A	1,2,3
	Long Short Term Memory		
7	Investigate Advanced Deep Learning Models and	U, A, An,	1,2,3,5,8,1
	Applications	C,E	0
8	Design and implement efficient algorithms to solve	U, A, An,	1,2,3,5,8
	various real-life problems by applying deep neural	C,E	
	network concepts and presenting the approach		
	effectively with appropriate tools.		
9	Acquire knowledge and skills through self-paced and	U, An, A,	1,2,3,5,7,
	self-directed learning and adapt to changing trends	C, E	8, 10
	through knowledge/skill updation/reskilling.		
*Reme	ember (R), Understand (U), Apply (A), Analyse (An), Eva	luate (E), \overline{Cre}	ate (C),
Skill (S	5)		

COURSE CONTENT Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO
			No.
UNIT I	Machine Learning Review: Concept, Applications and Key Elements of Machine Learning, Machine Learning Fundamentals - Binary Classification, Regression, Generalization, Regularization. Learning Algorithms, Capacity, Overfitting and Underfitting, Hyper Parameters and Validation Sets, Estimator, Bias and Variance, Maximum Likelihood Estimation, Bayesian Statistics, Building a Machine Learning Algorithm.	20	1
UNIT II	Training Deep Neural Networks: Introduction, Back Propagation, Setup and Initialization Issues, The Vanishing and Exploding	22	

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COM21C32 DEEP LEARNING

	Gradient Problems, Gradient -Descent Strategies, Batch Normalization Teaching Deep Learners to Generalize:		
	Introduction, The Bias-Variance Trade-off, Generalization Issues in Model Tuning and Evaluation, Penalty based Regularization		23
	Ensemble Methods, Early Stopping, Unsupervised Pretraining, Continuation and Curriculum Learning, Decomptor Sharing		2,5
	Continuation and Curriculum Learning, Parameter Sharing		
	Network Optimization, Basic Algorithms: SGD and Momentum,		
UNIT III	Parameter Initialization Strategies, Adaptive Learning Rates:	22	
	BFGS, Optimization Strategies and Meta-Algorithms, Batch		4,8,9
	Normalization, Coordinate Descent, Pretraining.		
	Convolutional Neural Networks: Convolution Operation, Pooling		
	Operation, Convolution-Detector-Pooling Building Block,		
UNIT IV	Convolution Variants, Intuition Neural Networks.Recurrent		
	Neural Networks: RNN Basics, Training RNNs, Bidirectional	24	
	RNNs, Encoder-Decoder Architecture, Gradient Explosion and Vanishing Gradient Clipping Auto encoders Long Short Term	21	5,6,8, 9
	Memory		,
	Advanced Deep Learning Models and Applications: Image		
	Processing, Natural Language Processing, Speech Recognition,	24	
UNIIV	video Analytics.	24	7.8.9
			7 - 7-

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Explicit Teaching, E-learning, Active co-operative learning, Inquiry-based instruction, Authentic learning, Library work and Group discussions					
Assessment	Mode of Assessment					
Types	A. Continuous Internal Assessment (CIA)					
	• Technical skills evaluation - Correctness of programs					
	• Internal Tests – Minimum two (Practical)					
	 Assignments -Lab Records, Practical and Viva 					
	Case studyB. Semester End Examination					

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21C32 DEEP LEARNING

- 1. Ian GoodfellowYoshuaBengio Aaron Courville, Deep Learning, The MIT Press.
- 2. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer.
- 3. Nikhil Ketkar, Deep Learning with Python: A Hands-on Introduction, Apress.
- 4. Li Deng, Dong Yu, Deep Learning: Methods and Applications, Foundations and Trends in Signal Processing ,Vol. 7, Nos. 3–4.
- 5. Sandro Skansi, "Introduction to Deep Learning from Logical calculus to Artificial Intelligence", Springer.
- 6. EthemAlpaydin, "Introduction to Machine Learning", 4th Edition, The MIT Press.
- 7. Tom M. Mitchell, "Machine Learning", 1st Edition, Tata McGraw-Hill Education.
- 8. Christopher M. Bishop, "Pattern Recognition and Machine Learning".
- 9. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press.
- 10. Kevin P. Murphy, "Machine Learning, 2nd Edition, The MIT Press.
- 11. Yegnanarayana B, Artificial Neural Networks, Prentice-Hall India Pvt. Ltd.
- 12. "Mastering Machine Learning: A Step-by-Step Guide with MATLAB", MathWorks.
- 13. Giuseppe Ciaburro, "MATLAB for Machine Learning", Packt Publishing Limited.
- 14. U Dinesh Kumar, Manaranjan Pradhan, "Machine Learning using Python", Wiley.



CO M21C33 DEEP LEARNING – LAB

SchoolName	School of Compu	iter Scieno	ces			
Programme	M.Sc.					
Course Name	Deep Learning –	LAB				
Type of Course	Core					
Course Code	COM21C33					
Names of Academic Staff & Qualifications	Prof. (Dr.) Anuj Mohamed, Ph D					
Course Summary & Justification	This course aims to provide foundations of machine learning and deep learning, including the ability to successfully implement, apply and test relevant learning algorithms. The students will also get acquainted with the design and implementation of efficient algorithms to solve various real-life applications ranging from speech and natural language processing to machine vision and medical imaging by applying advanced deep learning technologies.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutoria 1	Pract ical	Others	Total Learning Hours
	Explicit Teaching Assignments.		14	84		120
	Seminar etc.				22	120
Pre-requisite	Machine Learning	g & Neural	Networks			·



COM21C33 DEEP LEARNING – LAB

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.
No.		Domains	
1	Understand the concept of machine learning and its	U, A	1,3
	applications.		
2	Understand and apply gradient-descent techniques to	U,An,A,E	1,2,3,8
	train deep neural networks.		
3	Understand and apply generalization strategies	U, An, A	1,2,3
4	Understand and apply various Optimization techniques	U, An, A	1,2,3
	for training deep models		
5	Construct and train convolutional and recurrent neural	U,An,A,E	1,2,3,8
	networks.		
6	Understand the apply the concept of Auto encoders	U, An, A	1,2,3
	and Long Short Term Memory		
7	Investigate Advanced Deep Learning Models and	U, A, An,	1,2,3,5,8,1
	Applications	C,E	0
8	Design and implement efficient algorithms to solve	U, A, An,	1,2,3,5,8
	various real-life problems by applying deep neural	C,E	
	network concepts and presenting the approach		
	effectively with appropriate tools.		
9	Acquire knowledge and skills through self-paced and	U, An, A,	1,2,3,5,7,
	self-directed learning and adapt to changing trends	C, E	8, 10
	through knowledge/skill updation/reskilling.		
*Reme	mber (R), Understand (U), Apply (A), Analyse (An), Eva	luate (E), Cre	eate (C),
Skill (S	S)		

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Machine Learning Review: Concept, Applications and Key Elements of Machine Learning, Machine Learning Fundamentals - Binary Classification, Regression, Generalization, Regularization.Learning Algorithms, Capacity, Overfitting and Underfitting, Hyper Parameters and Validation Sets, Estimator, Bias and Variance, Maximum Likelihood Estimation, Bayesian Statistics, Building a Machine Learning Algorithm.	20	1
UNIT II	Training Deep Neural Networks: Introduction, Back Propagation, Setup and Initialization Issues, The Vanishing and Exploding Gradient Problems, Gradient -Descent Strategies, Batch Normalization. Teaching Deep Learners to	22	

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21C33 DEEP LEARNING – LAB

	Generalize: Introduction, The Bias-Variance Trade-off, Generalization Issues in Model Tuning and Evaluation, Penalty-based Regularization, Ensemble Methods, Early Stopping, Unsupervised Pretraining, Continuation and Curriculum Learning, Parameter Sharing		2,3
UNIT III	Optimization for Training Deep Models: Challenges in Neural Network Optimization, Basic Algorithms: SGD and Momentum, Parameter Initialization Strategies, Adaptive Learning Rates: RMSProp, Adam. Approximate Second Order Methods: Newton, BFGS, Optimization Strategies and Meta- Algorithms, Batch Normalization, Coordinate Descent, Pretraining.	22	4,8,9
UNIT IV	Convolutional Neural Networks: Convolution Operation, Pooling Operation, Convolution-Detector-Pooling Building Block, Convolution Variants, Intuition Neural Networks.Recurrent Neural Networks: RNN Basics, Training RNNs, Bidirectional RNNs, Encoder-Decoder Architecture, Gradient Explosion and Vanishing, Gradient Clipping, Auto encoders, Long Short Term Memory.	24	5,6,8,9
UNIT V	Advanced Deep Learning Models and Applications: Image Processing, Natural Language Processing, Speech Recognition, Video Analytics.	24	7,8,9

Teaching and	Classroom Procedure (Mode of transaction)
Learning	Explicit Teaching, E-learning, Active co-operative learning, Inquiry-based
Approach	instruction, Authentic learning, Library work and Group discussions
Assessment	Mode of Assessment
Types	A. Continuous Internal Assessment (CIA)
	• Technical skills evaluation - Correctness of programs
	• Internal Tests – Minimum two (Practical)
	• Assignments -Lab Records, Practical and Viva
	• Case study
	B. Semester End Examination



COM21C33 DEEP LEARNING -LAB

- **1.** Ian GoodfellowYoshuaBengio Aaron Courville, Deep Learning, The MIT Press.
- 2. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer.
- 3. Nikhil Ketkar, Deep Learning with Python: A Hands-on Introduction, Apress.
- **4.** Li Deng, Dong Yu, Deep Learning: Methods and Applications, Foundations and Trends in Signal Processing ,Vol. 7, Nos. 3–4.
- **5.** Sandro Skansi, "Introduction to Deep Learning from Logical calculus to Artificial Intelligence", Springer.
- 6. EthemAlpaydin, "Introduction to Machine Learning", 4th Edition, The MIT Press.
- 7. Tom M. Mitchell, "Machine Learning", 1st Edition, Tata McGraw-Hill Education.
- 8. Christopher M. Bishop, "Pattern Recognition and Machine Learning".
- 9. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press.
- **10.**Kevin P. Murphy, "Machine Learning, 2nd Edition, The MIT Press.
- 11. Yegnanarayana B, Artificial Neural Networks, Prentice-Hall India Pvt. Ltd.
- 12. "Mastering Machine Learning: A Step-by-Step Guide with MATLAB", MathWorks.
- 13. Giuseppe Ciaburro, "MATLAB for Machine Learning", Packt Publishing Limited.
- **14.**U Dinesh Kumar, Manaranjan Pradhan, "Machine Learning using Python", Wiley.



COM21C34 ADVANCED SOFTWARE DEVELOPMENT TOOLS –LAB

School Name	School of Compu	iter Scien	ces			
Programme	M.Sc.					
Course Name	Advanced Softwa	are Develo	opment To	ools –La	b	
Type of Course	Core					
Course Code	COM21C34					
Names of Academic Staff & Qualifications	Dr. Ivy Prathap P	h.D.				
Course Summary & Justification	This course provid Python libraries a important in today knowledge on the knowledge on ho Hadoop installat commands and sa the Hadoop system	des an insig nd Python y's comme le Big Da ow to imp ion in imple Map n.	ght into Ol for Data S ercial lands tta concep lement ba different oReduce p	oject orie Science. Scape. T tts. Th sic data operating rograms	big data i Big data i his course nis course structure g modes, to explore	pts in Python, s increasingly gives the best imparts the programs and run Hadoop the HDFS on
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutoria 1	Pract ical	Others	Total Learning Hours
	Explicit Teaching Assignments, Viva, Record Preparation etc.	-	14	42	64	120
Pre-requisite	Basic Python		1		1	



COM21C34 ADVANCED SOFTWARE DEVELOPMENT TOOLS –LAB

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.
No.		Domains	
1	Write, test and debug Python programs using object- oriented concepts	Α	1,2,3
2	Familiarize with Python libraries	U	1,2,3
3	Apply Python for Data science	A	1,2,3,4,7 10
4	Illustrate learning of data from Python	А	1,2,3,4
5	Understand the installation of Hadoop	U	1,2,3,4,7,1 0
7	Interpret the concepts of Hadoop cluster	E	1,2,3,4,7,1 0
8	Apply Hadoop to manage mining of huge data sets	A	1,2,3,4, 7,10
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Advanced Python: Object Oriented, OOPs concept, Class and object, Attributes, Inheritance, Overloading, Overriding, Data hiding, Operations Exception, Exception Handling, Except clause, Try - finally clause, User Defined Exceptions, Python Libraries. Introduction to Machine learning packages like NUMPY, SCIPY, PANDAS etc.	12	1,2
UNIT II	Python for Data Science: Pre-Processing of Data, Visualizing the Data, Exploratory Data Analysis, Clustering and identification of Outliers using Python, Performing Cross- Validation, Selection, and Optimization using Python, Learning from Data using Python	12	3,4
UNIT III	Introduction to Big Data and Hadoop Ecosystem: Install, configure and run Hadoop and HDFS, HDFS JAVA API, Map reduce, Hadoop ETL, Hadoop Reporting Tools.	11	5



COM21C34 ADVANCED SOFTWARE DEVELOPMENT TOOLS –LAB

UNIT IV	Hadoop Environment: Setting up Hadoop Cluster and HDFS Monitoring, Pig and HIVE, Apache Spark	11	6
UNIT V	Security in Hadoop, Administering Hadoop, HDFS- Monitoring & Maintenance, Hadoop benchmarks, Hadoop in the cloud.	10	7,8

Teaching and	Classroom Procedure (Mode of transaction)	
Learning	Explicit Teaching, E-learning, Active co-operative learning, Inquiry-based	
Approach	instruction, Authentic learning, Library work and Group discussions	
Assessment	Mode of Assessment	
Types		
	A. Continuous Internal Assessment (CIA)	
	• Technical skills evaluation - Correctness of programs	
	• Internal Tests – Minimum two (Practical)	
	 Assignments -Lab Records, Practical and Viva 	
	• Case study	
	B. Semester End Examination	

- 1. Ashok NamdevKamthane and Amit Ashok Kamthane, Programming and
- 2. ProblemSolving with Python, McGraw-Hill Education.
- 3. Irv Kalb, Learn to Program with Python, Apress.
- 4. Deepak Vohra, Practical Hadoop Ecosystem: A Definitive Guide to Hadoop-Related
- 5. Frameworks and Tools, Apress.
- 6. MayankBhushan, Big Data and Hadoop: Learn by Example, BPB Publications.



COM21E31 DATA SCIENCE

ELECTIVES

School Name	School of Cor	School of Computer Sciences				
Programme	M.Sc.					
Course Name	Data Science					
Type of Course	Elective					
Course Code	COM21E31					
Names of Academic Staff & Qualifications	Ms. Jissy Liz	Jose, M. 7	ſech			
Course Summary & Justification	The course p statistical and projects and o new, exciting statistical, al emerge in pro- Data. Data Sc including man and more.	rovides a machine delivering g, and fa gorithmic cessing, st cience is w cketing, ho	n insight learning t results. E st-paced o , and im coring, and widely use ealthcare,	into the da echniques o Data Scienc discipline t plementation extracting d in various finance, ba	ata scienc used in da e has em hat explo on challe knowledg is industry nking, po	e process, ata science erged as a pres novel enges that e from Big y domains, blicy work,
Semester	III					
Total StudentLearningTim e (SLT)	Learning Approach	Lectur e	Tutoria 1	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	36	120
Pre-requisite	Basics of Algorithms, Programming, and Statistical analysis.					



COM21E31 DATA SCIENCE

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.
N0.		Domains	
1	Understand the significance of data science and its key	U	2,10
	functionalities		
2	Analyse the characteristics of dataset and illustrate how	U, An, A	1.2,3,10
	to load, manage, and explore data.		
3	Choose and evaluate classification models, scoring	Е	1,2,3,10
	models, probability models, ranking models and		
	clustering models.		
4	Compare and apply various single variable and	An, A	1,2,3,10
	multivariable models suitable for data science.		
5	Perform preliminary statistical analysis, prediction and	A, S, C	1,2,3.8,10
	filtering on simple data sets using Python or R.		
6	Choose techniques for effective visualization and	An, A	1,2,3,10
	presentation of data.		
7	Perform Hadoop and Map-Reduce for data analysis.	An, A, C	1,2,3,10
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),			
Skill (S	()		

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction to data science - Data science process, Roles in a data science project, Stages of a data science project, Applications of data science, setting expectations - Determining lower and upper bounds on model performance, Loading data - Working with data from files, Working with relational databases, Applications of data science.	17	1
UNIT II	Exploring data - Using summary statistics to spot problems, Spotting problems using graphics and visualization, Managing data - cleaning data, Sampling for modelling and validation. Choosing and evaluating models - Mapping problems to machine learning tasks, Evaluating classification models, scoring models, probability models, ranking models and clustering models. Validating models - Identifying common model problems, quantifying model soundness, Ensuring model quality, Case Studies.	18	2,3



COM21E31 DATA SCIENCE

UNIT III	Single variable and multivariable models, Linear and logistic regression, unsupervised methods, Bagging, and random forests, Generalized additive models, kernel methods to increase data separation, Support vector machines.	17	4,5
UNIT IV	Delivering results - Documentation - Using comments and version control for running documentation, deploying models, producing effective presentations - Presenting results to the project sponsor, presenting model to end users and other data scientists.	16	6
UNIT V	Introduction to Big data and Distributed file system - Algorithm using Map Reduce, Understanding Map Reduce architecture, Hadoop, Writing Hadoop Map-Reduce programs, Loading data into HDFS, Executing the Map phase, Shuffling and sorting, Reducing phase execution.	16	7

Teaching and	Classroom Procedure (Mode of transaction)		
Learning	Direct Instruction: Explicit Teaching, E-learning		
Approach	Interactive Instruction: Active co-operative learning, Seminar, Group		
	Assignments		
	Authentic learning: Library work and Group discussion, Presentation by		
	individual student/Group representative.		
Assessment	Mode of Assessment		
Types	A. Continuous Internal Assessment (CIA)		
	• Internal Tests – Minimum two (Extended answers)		
	• Seminar –		
	 Research Literature review 		
	 Report writing 		
	 Presentation 		
	• Assignments – Written, Oral presentation and viva.		
	• Case study		
	B. Semester End Examination		



COM21E31 DATA SCIENCE

- 1. Nina Zumel, John Mount "Practical Data Science with R", Manning Publications.
- 2. Boris Lublinsky, Kevin T. Smith. AlexcyYakubovich, "Professional Hadoop Solutions", Wiley.
- 3. RajkumarBuyya, Rodrigo N. Calheiros, Amir VahidDastjerd, "Big Data Principles and Paradigms", Morgan Kaufmann.
- 4. Ervin Varga, "Practical Data Science with Python 3, Synthesizing Actionable Insights from Data".
- 5. Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from The Frontline", O'Reilly.
- 6. Jure Leskovec, AnandRajaraman, Jeffrey D. Ullman, "Mining of Massive Datasets". Cambridge University Press.
- 7. Tony Ojeda, Sean Patrick Murphy, Benjarnin Bengfort. AbhijitDasgupta. "Practical Data Science Cookbook", Packt Publishing Limited.



COM21E32 INTERNET OF THINGS AND BLOCK CHAIN TECHNOLOGIES

Name of School	School of	Computer	Sciences			
Programme	M. Sc					
Name of Course	Internet o	f Things a	and Block	Chain Teo	hnologies	
Type of Course	Elective					
Course Code	COM21E.	32				
Names of Academic Staff & Qualifications	Dr. P. Abd	ul Jabbar,	MPhil, Ph	ıD		
Course Summary & Justification	The course covers the theoretical concept of the design, Configure, and implementation of connected devices block chain. Areas include IOT, Connections, Smart Object, Smart environment and privacy issues of IOT and block chain.					
Semester	III					
Total Student Learning Time SLT	Learning Approac hLectureTutoria 1PracticalOthersTotal Learning Hours					
Direct Teaching Assignments, Seminars etc.		42	14	28	36	120
Pre-requisite	The learne	r must hav	ve gained t	he fundame	ental concep	ots of software.



COM21E32 INTERNET OF THINGS AND BLOCK CHAIN TECHNOLOGIES

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.				
1	Initiation of technical dimensions of blockchain in IOT mechanism and key issues in internet of things.	A,R,U	1,2,10				
2	Understand and formulate Key Block chain techniques importance of security in decentralised application	C,S,E	3,4,5				
3	Conceptualize IOT and smart object in smart environment using various IOT environment.	C,A,S ,E	3,4,5				
4	Identify the security privacy issues in IOT and cloud environment.	U,An,C,A	3,4,5 ,8				
5	Manage and develop secure system using IOT and Block chain.	A,C,,E	3,4				
6	Formulate and evaluate remote controllable system.	S,C,E	5,6,7, 3,4				
7	Demonstrate the ability to analyze, design, apply and use of various cryptography method to secure data and connected device.	U,A,E,An	5,6,7,8,9,1 0				
*Reme Skill (S	*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)						

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	СО
			No.
UNIT I	Introduction to Blockchain in Internet of Things, Overview, Blockchainapplicationin internet of things, Security and privacy in Internet of things, Technical dimensions of blockchain, Consensus mechanism, Key issues in internet of things, Architectures of Internet of things, Evaluation metrics of internet of things.	15	1
UNIT II	Key Blockchain concepts, Nodes, Cryptocurrency, Tockens, Cryptography, Modern encription, Public and Private keys, Hash, Ledgers, Proof of work, Proof of stake, Hyperledger, Ripple, Unearthing Etherum, Second generation application of blockchain techniques, Smart contracts, Decentralised application.	20	2
UNIT III	Internet of things concepts, Smart object and smart environment, Machines to machines communication, IoT framework, Network connectivity, Sensors, Actuator, Radio	15	3



COM21E32 INTERNET OF THINGS AND BLOCK CHAIN TECHNOLOGIES

	frequency identification, Middleware Technologies, Data Exchange.		
UNIT IV	Security and Privacy issues in internet of things; Confidentiality, Integrity, Authentication, Privacy concerns in IoT; Identity, Location, Trajectory, Blockchain in privacy preserving cloud data storage services; Technical dimension in cloud data preserving services, Basic techniques, Threat model, Data submission, Primitiveness identification, Blockchain enabled controllable data management, System initialization, Document modification, Documents Management, User registration, Voting and counting, Use case.	20	4,6
UNIT V	Quantitative analysis; Problem of interest, Programs as graph, Factors determining execution time, Execution time analysis, Security and Privacy; Cryptographic primitives, Protocol and networks security, Information flow, Identity, Blockchain Protected Identity, Blockstack, Microsoft, IBM's Trusted Identity, Blockchain and IoT, Toyota, IBM.	14	5,7

Classroom	Mode of transaction
Procedure	Direct Instruction: Brain storming lecture, Practical Session, 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	Mode of Assessment
Types	A. Continuous Internal Assessment (CIA)
	18. Internal Tests – Minimum two (Extended answers / Practical)
	19. Seminar –
	Research Literature review
	Report writing
	 Presentation
	20. Assignments – Written, Practical, Oral presentation and viva
	21. Case study/Mini project
	D. Converter End Energinetion
	B. Semester End Examination



COM21E32 INTERNET OF THINGS AND BLOCK CHAIN TECHNOLOGIES

- 1. Shiho Kim, Peng Zhang and Ganesh Chandra, Role of Rlockchain Technologies in IoT Applications, Academic Press, Elsevier.
- 2. LiehuangZhu,KekeGai and Meng Li, Blockchain Technology in Internet of Things, Springer International Publishing.
- 3. Qusay F. Hassan, Internet of Things A to Z; Technologies and Applications, Wiley.
- 4. ChellammalSurianarayanan, Kavita Saini, Pethuru Raj, Blockchain Technology and Applications, CRC Press.
- 5. Ahmed Banafa, Secure and Smart Internet of Things (IoT) Using Blockchain and Artificial Intelligence (AI), River Publishers.



COM21E33 CLOUD COMPUTING

Name of School	School of Computer	Sciences				
Programme	M. Sc					
Name of Course	Cloud Computing					
Type of Course	Elective					
Course Code	COM21E33					
Names of Academic Staff & Qualifications	Dr. Abdul Jabbar P,	M Phil, Ph	D			
Course Summary & Justification	The course covers th and management of cloud service model	ne advance data and i s, security,	d concept o nfrastructur testing, infr	f the configu e in all serv astructure a	ration, dis ices. Areas nd its confi	tribution include guration
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total
	Direct Teaching Assignment, Seminars etc	42	14	28	36	120
Pre-requisite	The learner must Computing	have gain	ed the fur	damental c	concepts o	f Cloud



COM21E33 CLOUD COMPUTING

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.			
No.		Domains				
1	Determine the importance of Cloud Computing concept	R,U	1,2,10			
	in the modern computing environment.					
2	Understand various Cloud Models and service to	A,S,E	1,3,4,5			
	manage the web-based applications.					
3	Analysis and evaluate various cloud security	An,S,E	2,3,4,5			
	requirements in secure development practice.					
4	Expertise in secure cloud software testing practice in	U,A,C,	3,4,5			
	software quality assurance.					
5	Recognize and management of cloud computing threats	A,C,E	3,4,5			
	in infrastructure.					
6	Formulate and evaluate possible solution of the virtual	An,S,C,E	1,3,4,5,6			
	machine, and select and measure the chosen cloud					
	environment.					
7	Demonstrate the ability to analyze, design and apply	E,U,R,A	5,6,7,8,9,1			
	cloud infrastructure to manage data.		0			
*Reme	*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),					
Skill (S	S)					

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Cloud computing, History of Cloud Computing, Cloud service providers, Properties, Characteristics - Benefits of Cloud Computing- Cloud Storage-Cloud computing vs. Cluster computing vs. Grid computing-Role of Open Standards- Companies in the Cloud Today.	15	1,4
UNIT II	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
UNIT III	Security objectives, Services, Security design principles, secure development practice, Approaches to Cloud Software Requirements Engineering.	15	3,4



COM21E33 CLOUD COMPUTING

UNIT IV	Secure Cloud Software Testing, Testing for SQA,	20	6
	Conformance, functional, Performance & security testing.	-	
UNIT V	Threats to Infrastructure, Data and Access Control, Cloud		
	Service Provider Risks- Back-Door, Spoofing, Man-in-the-		57
	Middle, Replay threats, TCP Hijacking, Social Engineering,	14	5,7
	Dumpster Diving, Password Guessing, Trojan Horses and		
	Malware.		

Classroom Procedure	Mode of transaction Direct Instruction: Brain storming lecture, Practical Session, 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	Mode of Assessment
Types	 A. Continuous Internal Assessment (CIA) Internal Tests – Minimum two (Extended answers / Practical) Seminar – Research Literature review Report writing Presentation Assignments – Written, Practical, Oral presentation and viva Case study/Mini project B. Semester End Examination

- 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.



COM21E34 FUZZY LOGIC AND NATURE INSPIRED COMPUTING

School Name	School of Computer Sciences					
Programme	M.Sc.					
Course Name	Fuzzy Logic a	nd Nature	Inspired C	Computing		
Type of Course	Elective					
Course Code	COM21E34					
Names of Academic	Prof. Dr. Bind	u V R, M	. Sc., Ph. I).		
Staff & Qualifications						
Course Summary &	The course pr	ovides an	overview	of concept	ts in fuzzy	y logic and
Justification	nature inspire	d comput	ing. Upon	completio	n of this	course, the
	students will	comprehe	end the fu	izzy logic	and the	concept of
	fuzziness invo	olved in v	arious sys	tems and f	uzzy set t	heory. The
	students will a	also get th	e concepts	s, principles	s, and app	lications of
	in nature It	offers stu	dents an d	processes a	to appre	ciate those
	concepts dev	elon new	insights an	nd methods	and turr	them into
	practical prob	lem-solvi	ng and mo	delling. Pa	rticular e	xamples of
	nature-inspired computing approaches included in this course are					
	Genetic Algorithms, Ant Colony Algorithms, Particle Swam					
	algorithms and Artificial Bee Colony algorithms					
Semester	III					
Total						
StudentLearningTim	Learning	Lectur	Tutoria	Practical	Others	Total
e (SLT)	Approach	e	1			Learning
						Hours
	Explicit					
	Teaching	42	14	28		
						120
	Seminar,					
	Assignments				36	
	etc.					
			<u> </u>			
Pre-requisite	Basics of Alg	orithms, l	Programm	ning, and S	tatistical	analysis.



COM21E34 FUZZY LOGIC AND NATURE INSPIRED COMPUTING

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Comprehend the fuzzy logic and the concept of fuzziness involved in various systems.	U	2,10
2	Understand the concepts of fuzzy sets, fuzzification, defuzzification, fuzzy rules, fuzzy inference systems etc. and apply fuzzy logic control to real time system.	U, A	1.2,3,10
3	Understand the underlying nature inspired principles of Genetic Algorithms, Ant Colony Algorithms, Particle Swam algorithms and Artificial Bee Colony algorithmsand the key ideas and steps involved in it.	U,A,An	1,2,3,10
4	Compare and analyse different nature inspired computing approaches and understand the strength, weakness, and suitability and applications of each.	U,An,A,E	1,2,3,10
5	Apply nature-inspired algorithms to optimization, design and learning problems.	S,A,An	1,2,3.4,10
6	Evaluate performance of Nature inspired algorithm in context of problem solving in optimized manner	E,An	1,2,3,10
*Reme Skill (S	mber (R), Understand (U), Apply (A), Analyse (An), Evalu 5)	uate (E), Crea	te (C),

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hr	CO No.
		S	
UNIT I	Fuzzy Logic: Concepts of uncertainty and imprecision; Properties and operations on classical setsand fuzzy sets; Classical and fuzzy relations; Membership functions and its types; Fuzzification;Fuzzy rule-based systems; Defuzzification; Fuzzy propositions; Fuzzy extension principle; Fuzzyinference system, Fuzzy Logic Control Systems, Recent applications.	17	1,2



COM21E34 FUZZY LOGIC AND NATURE INSPIRED COMPUTING

UNIT II	Genetic Algorithms: Difference between traditional algorithms and Genetic Algorithm (GA); Basic concepts of GA; Working principle;Encoding methods; Fitness function; GAOperators:Reproduction, Crossover, Mutation; Convergence of GA;Detailed algorithmic steps;Adjustment of parameters; Multicriteria optimization; Solution of typical problems using geneticalgorithm; Recent applications.	18	3
UNIT III	Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimisation, variations of ACO.	17	3,4,5,6
UNIT IV	Particle Swam algorithms - particles moves, particle swarm optimization, variable length PSO, applications of PSO.	16	3,4,5,6
UNIT V	Artificial Bee Colony algorithms - ABC basics, ABC in optimisation, multi-dimensional bee colony algorithms, applications of bee algorithms, Case studies and Hybrid Systems.	16	3,4,5,6

Teaching and LearningApproac	Classroom Procedure (Mode of transaction)
h	Direct Instruction: 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 A. Continuous Internal Assessment (CIA) Internal Tests – Minimum two (Extended answers) Seminar – Research Literature review Report writing Presentation Assignments – Written, Oral presentation and viva. Case study



COM21E34 FUZZY LOGIC AND NATURE INSPIRED COMPUTING

- **1.** D. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley.
- **2.** S. Rajasekaran and G. A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.
- **3.** S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, 2nd ed., Wiley India.
- **4.** J. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House.
- **5.** G. Klir, B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson.
- 6. John Yen, Reza Langari, Fuzzy Logic –Intelligence, Control and Information, PearsonEducation.
- **7.** Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer.
- **8.** Floreano, D. and C. Mattiussi, "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press.
- **9.** Leandro Nunes de Castro, "Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications" Chapman & Hall/ CRC, Taylor and Francis Group.
- **10.**Marco Dorrigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India,New Delhi.



COM21E35 NATURAL LANGUAGE PROCESSING

School Name	School of Cor	School of Computer Sciences				
Programme	M.Sc.					
Course Name	Natural Langu	age Proce	essing			
Type of Course	Elective					
Course Code	COM21E35					
Names of Academic Staff & Qualifications	Prof. (Dr.) Pu	shpalatha	K P, PhD			
Course Summary & Justification	The course provides an insight into the principles and methodological introduction to the most widely used and effective strategies for natural language processing. The course examines various NLP models and algorithms, text retrieval strategies, exploratory analysis, text summarization and text generation techniques. NLP has applications in many domains such as computer science, journalism, social science, psychology, political science etc. where processing of text data is crucial.					
Semester	III					
Total StudentLearningTim e (SLT)	Learning Approach	Lectur e	Tutoria 1	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	36	120
Pre-requisite	Basics of Alg	gorithms a	and Statisti	cal analysis	8.	



COM21E35 NATURAL LANGUAGE PROCESSING

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO No.
No.		Domains	
1	Understand the fundamental concepts and steps of	U	2,10
	natural language processing.		
2	Distinguish among the various NLP techniques,	U, An, E	1,2,10
	considering the assumptions, strengths, and weaknesses		
	of each		
3	Apply preliminary pre-processing on text data, extract	A, An, C	1,2,3,10
	features and tokenize it.		
4	Develop a text classifier using machine learning	R, U, C, E	1,2,3,10
	algorithms - select appropriate model and analyse its		
	performance.		
5	Apply various text retrieval methods and analyse large	A, An	1,2,3,10
	volume of text data generated		
6	Compare various text summarization and text generation	An, E	1,2,10
	methods		
7	Use NLP methods to analyze sentiment of a text	A, An, C	1,2,3,10
	document		
*Reme	mber (R), Understand (U), Apply (A), Analyse (An), Evalu	ıate (E), Crea	te (\overline{C}),
Skill (S	S)		

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO
			No.
UNIT I	Introduction to Natural Language Processing, History of NPL, 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, Preprocessing.	16	1
UNIT II	Basic Feature Extraction Methods, Introduction, Types of Data, Cleaning Text Data, Tokenizing Texts with Different Packages – Keras and TextBlob, Types of Tokenizers, Stemming, Lemmatization, Singularizing and Pluralizing Words, Language Translation.	22	2, 3
UNIT III	Developing a Text classifier, Machine Learning, Various Clustering Algorithms, K-Means Clustering, Supervised Learning, Various Classifiers, Regression, Tree Methods,	26	

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21E35 NATURAL LANGUAGE PROCESSING

	Sampling, Dimensionality Reduction, Deciding on a Model Type, Performance of a model, Saving and Loading Models.		4
UNIT IV	Collecting Text Data from the Web, Collecting Data by Scraping Web Pages, Requesting Content from Web Pages, Dealing with Semi-Structured Data, Dealing with Online JSON Files, XML Files, Using APIs to Retrieve Real-Time Data, Topic Modelling, Exploratory Data Analysis, Bag of Words, Modelling Algorithms, Latent Semantic Analysis, Latent Dirichlet Allocation, Topic Fingerprinting.	26	3,4,5
UNIT V	Text Summarisation and Text Generation, Introduction, Extractive Text Summarisation, Abstractive Text Summarisation, Summarizing Text using Gensim, Word Frequency, Generating Text with Markov Chains, Vector Representation, Encoding, Positional Character Level Encoding, One-Hot Encoding, Word-Level One Hot Encoding, Word Embeddings, Word2Vec, Using Pre-trained Word Vectors, Document Vectors Sentiment Analysis, Types of Sentiments, Applications, Tools, Python NLP Libraries, Understanding Data for Sentiment Analysis, Training Sentiment Models.	22	2, 6, 7



COM21E35 NATURAL LANGUAGE PROCESSING

	Classroom Procedure (Mode of transaction)					
Teaching and	Direct Instruction: Explicit Teaching, E-learning					
Learning	Interactive Instruction: Active co-operative learning, Seminar, Group					
Approach	Assignments					
	Authentic learning: Library work and Group discussion, Presentation by					
	individual student/Group representative.					
Assessment	Mode of Assessment					
Types						
	A. Continuous Internal Assessment (CIA)					
	• Internal Tests – Minimum two (Extended answers)					
	• Seminar –					
	 Research Literature review 					
	 Report writing 					
	 Presentation 					
	• Assignments – Written, Oral presentation and viva.					
	• Case study					
	B. Semester End Examination					

REFERENCES

- 1. Dwight Gunning:Sohom Ghosh, Natural Language Processing fundamentals, Packt Publishing.
- 2. PalashGoyal and Sumit Pandey, Deep Learning for Natural Language Processing: Creating Neural Networks with Python, Apress.
- 3. Steven Bird, Ewan Klein, Edward Loper, *Natural Language Processing with Python Analyzing Text with the Natural Language Toolkit* (O'Reilly, website 2018) http://www.nltk.org/book/
- 4. Dipanjan Sarkar, *Text Analytics with Python* (Apress/Springer)

https://link-springer-com.proxy.uchicago.edu/book/10.1007%2F978-1-4842-2388-8

- 5. Stanford University CS224n: Natural Language Processing with Deep Learning http://web.stanford.edu/class/cs224n/
- 6. Paul Vierthaler'sStylometric PCA and Network Data Explorer <u>https://www.pvierth.com/pca</u>



COM21CE36 DIGITAL SIGNAL PROCESSING AND SPEECH TECHNOLOGIES

School Name	School of Computer Sciences					
Programme	M. Sc.					
Course Name	Digital Signal	Processin	g and Spe	ech Techn	ologies	
Type of Course	Elective					
Course Code	COM21E36					
Names of Academic Staff & Qualifications	Prof. (Dr.) Anu Ph. D.	j Mohame	ed			
Course Summary & Justification	This course covers the concepts and techniques of modern digital signal processing which are fundamental to all the signal/speech processing, applications. The students will learn the basic concepts required to design and develop efficient speech/speaker					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lectur e	Tutoria 1	Practica 1	Other s	Total Learning Hours
	Explicit Teaching Seminar, Assignments, etc.	42	14	28	36	120
Pre-requisite	Mathematical F	Foundation	ns, Program	nming Skil	ls	•



COM21CE36 DIGITAL SIGNAL PROCESSING AND SPEECH TECHNOLOGIES

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the basic concepts of speech and fundamental signal processing approaches to speech spectral analysis.	U, A	1,3
2	Analyze various features of speech and understand the techniques of extracting the features and pattern comparison techniques.	U, A, An	2, 3,4
3	Understand statistical modeling using Hidden Markov Models and their implementation issues.	U, A, An,C	1, 2, 3,4
4	Apply Viterbi Search and Baum-Welch algorithms	U,An,A,E	1,2,3,8
5	Understand the architecture and various models of continuous speech recognition system	U, An, A, C	1,2,3,4
6	Design and development speech and speaker recognition systems	U, An, A, C,E	1,2,3,4,8
7	Apply methods of text to speech synthesis for different applications.	U,An,A	1,2,3
8	Design and implement emotion recognition systems	U, An, A, C,E	1,2,3,4,8
9	Design and implement efficient algorithms to solve various speech related problems and presenting the approach effectively with appropriate tools.	U, A, An, C,E	1,2,3,5,8
10	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, 10
*Reme (S)	mber (R), Understand (U), Apply (A), Analyse (An), Evalue	ate (E), Create	e (C), Skill

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
UNIT I	Introduction: Fundamentals of Speech, The Human Speech Production Mechanism, LTI Model for Speech Production, Nature of the Speech Signal, Linear Time-Varying Model, Phonetics, Types of Speech, Voiced and Unvoiced	18	

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21CE36 DIGITAL SIGNAL PROCESSING AND SPEECH TECHNOLOGIES

	Decision Making, Audio File Formats: Nature of the WAV File. Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics, Acoustics of speech production; Review of Digital Signal Processing concepts; ShortTime Fourier Transform, Filter- Bank and LPC Methods.		1,10
UNIT II	Pitch and Formants, Fundamental Frequency or Pitch Frequency, Parallel Processing Approach for Calculation of Pitch Frequency, Pitch Period Measurement, Formants and Their Relation With LPC, Evaluation of Formants, Estimation of Formants. Homomorphic Processing, Cepstral Analysis of Speech: Cepstral Coefficients, The Auditory System as a Filter Bank, Mel Frequency Cepstral Coefficients, Perceptual Linear Prediction, Log Frequency Power Coefficients, RelAtiveSpecTrAl Perceptual Linear Prediction, Short-Time Spectral Analysis of Speech, Wavelet Transform Analysis of Speech.	16	2,9,10
UNIT III	Hidden Markov Models: Markov Processes, HMMs, Evaluation, Optimal State Sequence, Viterbi Search, Baum- Welch Parameter Re-estimation; Implementation issues.	14	3,4,9, 10
UNIT IV	Speech Recognition Systems, Architecture of a Large Vocabulary Continuous Speech Recognition System, Deterministic and Statistical sequence Recognition for ASR, Statistical Pattern Recognition and Parameter Estimation, VQ- HMM-Based Speech Recognition, Discriminant Acoustic Probability Estimation, Word Spotting/Keyword Spotting, Speech Recognition and Understanding, Speaker Recognition, Speech Enhancement, Adaptive Echo Cancellation.	18	5,6,9, 10
UNIT V	A Text-to-Speech System, Synthesizer Technologies, Speech Synthesis Using Other Methods, Speech Transformations, Emotion Recognition from Speech, Watermarking for Authentication of a Speech/Music Signal.	18	7,8,10


COM21CE36 DIGITAL SIGNAL PROCESSING AND SPEECH TECHNOLOGIES

Teachinque	Classroom Procedure (Mode of transaction)			
and Learning	Direct instruction: Brain storming lecture, Explicit leaching, E-learning,			
Approacn	Interactive Instruction: Active co-operative learning, Seminar, Group			
	Assignments Authentic learning: Library work and Group discussion Presentation by			
	individual student/Group representative			
	individual student/Group representative.			
Assessment	Mode of Assessment			
Types	A. Continuous Internal Assessment (CIA)			
	• Internal Tests – Minimum two (Extended answers / Practical)			
	• Seminar –			
	 Research Literature review 			
	 Report writing 			
	 Presentation 			
	• Assignments – Written, Practical, Oral presentation and viva			
	Case study/Mini project			
	B. Semester End Examination			

REFERENCES

- **1.** S.D Apte, Speech and Audio Processing, Wiley India Edition.
- **2.** Rabiner Lawrence R., and Biing-Hwang Juang, Fundamentals of Speech Recognition, Prentice Hall International.
- **3.** D. Jurafsky and J. Martin, Speech and Language Processing An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Pearson Education.
- **4.** Gold Ben, Nelson Morgan, and Dan Ellis, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, John Wiley & Sons.
- 5. Benesty Jacob, M. Mohan Sondhi, and Yiteng Huang, Handbook of speech processing, Springer.
- 6. Katagiri S., Handbook of Neural Networks for Speech Processing, Artech House, Boston.
- 7. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, Pearson Education / PHI, India.
- **8.** A.V. Oppenheim, R. W. Schaffer, Discrete Time Signal Processing, Prentice Hall of India, New Delhi.
- 9. Andreas Antoniou, Digital Signal Processing, Tata McGraw Hill, NewDelhi.
- **10.** M. H. Hayes, Schaums Outlines of Digital Signal Processing, Tata McGraw Hill, India.

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21C41 MAIN PROJECT & COMPREHENSIVE VIVA-VOCE

FOURTH SEMESTER

School Name	School of Co	omputer So	ciences			
Programme	M.Sc.	M.Sc.				
Course Name	Main Projec	et & Comp	rehensive	Viva-voce		
Type of Course	Core					
Course Code	COM21C41					
Names of Academic Staff & Qualifications	Dr. Pushpala	itha K P, P	'nD			
Course Summary & Justification	The course is meant for developing software/algorithms based on innovative ideas, applying all the knowledge and skills they acquired during the previous three semesters. At the end of the course, their practical knowledge, skills and ability in designing and developing software with new objectives are evaluated. This course also gives them an opportunity to understand what their strengths and weakness in the skills they were expected to be experts. This also improves their confidence in working in any research and development environment. The students are benefited in growing a confidence in attending technical interviews for job opportunities in any R&D divisions of any industry or in educational institutions. This course gives them training and confidence in working in any real time research and development environment. The students are benefited in increasing job opportunities in any R&D divisions of any industry or in educational institutions. This course gives them training and confidence in working in any real time research and development environment. The students are benefited in increasing job opportunities in any R&D divisions of any industry or in educational institutions.The course is aimed to evaluate the theoretical and practical knowledge they acquired in all the previous semesters of the programme.					
Semester	IV					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutoria 1	Practical	Others	Total Learning Hours
	Self Practicing					600
Pre-requisite	Knowledge a using variou	and practic s IT techno	al experie	nce in deve	loping sof	tware



COM21C41 MAIN PROJECT & COMPREHENSIVE VIVA-VOCE

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcomes	Learning Domain	PSO No.
1	Identify socially relevant problems or research challenges within a specific subject area in Computer Science. Utilize relevant literature survey to investigate the problem, critically evaluate existing solutions or approaches to similar problems and identify the research gap.	U, An, E	1,2,3,6,7
2	Develop innovative approaches or methodologies to address the identified problems effectively using state-of-the art tools and technologies maintaining ethical standards. Demonstrate the ability to apply theoretical concepts to real-world problem solving scenarios at Multidisciplinary/Interdisciplinary/Transdisciplinary levels. Document and prepare a technical report of the entire project.	U, An, A, E , C, S	3, 4, 6, 7, 8, 9, 10
3	Present and demonstrate the problem solutions in a clear and effective way with the aid of appropriate tools adhering to academic integrity standards. Answer queries and justify the methodology, implementation and results obtained in a convincing manner during the project viva-voce.	A, An, C, S	5, 8
4	Proficiency in exhibiting the knowledge and skills acquired during the course of study through curriculum, self-paced and self-directed learning and adapt to changing trends and demands.	U, R, A, An, E, C, S	10

Teaching and	Classroom Procedure (Mode of transaction)					
Learning	Direct Instruction: Explicit Teaching, E-learning					
Approach	Interactive Instruction: Active co-operative learning, Seminar, Group					
	Assignments					
	Authentic learning: Library work and Group discussion, Presentation by					
	individual student/Group representative.					
Assessment	Mode of Assessment					
Types	A. Continuous Internal Assessment (CIA)					
	• Interim presentation and viva.					
	Reports preparation and submission					
	 Research Literature review 					
	 Main Project Report writing 					
	 Presentation 					
	Internal Project Presentation and Evaluation					
	• Case Study					
	B. Semester End Examination					

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21C41 MAIN PROJECT & COMPREHENSIVE VIVA-VOCE

References

1. Books and e-resources on Machine Learning, Deep Learning, Python Packages referred in all related courses in all three semesters.



COM21031 FUNDAMENTALS OF PROGRAMMING

School Name	School of Computer Sciences					
Programme	M.Sc.					
Course Name	Fundamental	ls of Prog	ramming			
Type of Course	Core					
Course Code	COM21031					
Names of Academic Staff & Qualifications	Ms. Jissy Liz	Jose, M. 7	ſech			
Course Summary & Justification	The course provides an insight into the basics of problem-solving techniques, object-oriented programming (C++), Open-Source Software (Linux), programming in Python and documentation & presentation tools. The course is fundamental in nearly any computer programming so that these concepts help to create computer applications that can be used to solve real-world problems					
Semester	ÎII					
Total StudentLearningTim e (SLT)	Learning Approach	Lectur e	Tutoria 1	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	36	120
Pre-requisite	Nil					



COM21031 FUNDAMENTALS OF PROGRAMMING

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Acquire fundamental knowledge in machine language programming, assembly language programming and high-level language programming along with problem solving techniques and analytical thinking.	А	1,2,3,4,10
2	Understand fundamental programming concepts and methodologies that are essential to build good high level language programs in C++ and Python.	U	1,2,3,10
3	Apply the concepts of object-oriented programming for solving real world problems.	R, A, An, C	1,2,3,4,10
4	Design, implement, test and debug programs in C++	C, An, E	1,2,3,4,6,8,1 0
5	Familiarise with open-source software like Linux, use Linux commands to manage files and directories and develop shell programs.	U, A	1,2,3,4,6,10
6	Design, implement, test and debug programs in Python	C, An, E	1,2,3,4,6,8,1 0
7	Work with various documentation and presentation tools	U, A, C	1,2,3,4,9,10
*Reme (S)	mber (R), Understand (U), Apply (A), Analyse (An), Ev	aluate (E), Ci	reate (C), Skill



COM21031 FUNDAMENTALS OF PROGRAMMING

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Unit	Course description	Hrs	CO No.
	Introduction to Problem Solving, Steps for Problem Solving,		1
UNIT I	Machine Language Programming, Assembly Language Programming, High Level Language Programming.	15	
UNIT II	Basics of Object-Oriented Programming & C++,Introduction to Object Oriented Programming (OOP), Procedural vs. Object oriented programming, Concepts of OOP, Benefits and applications of OOP. Overview of C++, Program structure, Identifiers, Variables, Constants, enum, Data Types, Operators and Control Structures, Functions-declaration and definition, Arrays & Strings, Basics of Object & Classes, Member functions, Private and Public members, Scope resolution operator, Concept of inheritance, types of inheritance: single, multiple, multilevel, hierarchical, hybrid, protected members.	18	2,3,4
UNIT III	Concept of open-source software – GNU/Linux – Different distribution of Linux - Features of Linux, Advantages - Linux Architecture- Linux directory commands - Linux File commands - Shell Programming- Comparison of Windows and Linux operating systems.	18	5
UNIT IV	History- Features in python- Working with python- Basic syntax- variables and data types-Operators-Conditional statements- Loops- Functions-Lists & Dictionaries- Modules.	18	6
UNIT V	Documentation and Presentation Tools.	15	7



COM21031 FUNDAMENTALS OF PROGRAMMING

Teaching and	Classroom Procedure (Mode of transaction)				
Learning	Direct Instruction: Explicit Teaching, E-learning				
Approach	Interactive Instruction: Active co-operative learning, Seminar, Group				
	Assignments				
	Authentic learning: Library work and Group discussion, Presentation by				
	individual student/Group representative.				
Assessment	Mode of Assessment				
Types	A. Continuous Internal Assessment (CIA)				
	• Internal Tests – Minimum two (Extended answers)				
	• Seminar –				
	 Research Literature review 				
	 Report writing 				
	Presentation				
	• Assignments – Written, Oral presentation and viva.				
	• Case study				
	B. Semester End Examination				

REFERENCES

- 1. Robert Lafore, "Object Oriented Programming in C++", McGraw Hill
- 2. Bjarne Stroustrup, "The C++ Programming Language", Addison Wesley
- 3. Christopher Negus, "Linux Bible", Wiley India Edition
- 4. Richard Blum & Christine Bresnahan, "Linux Command Line and Shell Scripting", Wiley
- 5. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd
- 6. Peter Norton & Alex Samuel, "Beginning Python", David Aitel-wrox publications



COM21032 PYTHON PROGRAMMING FOR SCIENTIFIC RESEARCH

School Name	School of Computer Sciences					
Programme	M.Sc.					
Course Name	Python Progr	amming fo	or Scientifi	ic Research	l	
Type of Course	Open Course					
Course Code	COM 21 O32					
Names of Academic Staff & Qualifications	Dr. Abdul Jal	bbar P. Ph	.D			
Course Summary & Justification	The course offers a comprehensive insight into problem-solving techniques and research development using Python. Students gain in-depth knowledge of Python programming to effectively tackle complex challenges and advance their research endeavours					
Semester	III					
Total						
StudentLearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar	40	24	36	20	120
	Assignments etc.					
Pre-requisite	Nil				<u>.</u>	



COM21032 PYTHON PROGRAMMING FOR SCIENTIFIC RESEARCH

COURSE OUTCOMES (CO)

CO.	Expected Course Outcome	Learning	PSO No.
No.		Domains	
1	Acquire fundamental knowledge in data and data representation.	R, U	1,2,3,
2	Perform fundamental operations in Python for effective storage,	R, U	
	organisation, manipulation and management of data.		2,3,4,
3	Acquire proficiency in mathematical functionalities, data	R, A, An,	4,5,6,7
	analysis, computing formulas, automation and develop a wide	С	
	range of applications.		
4	Create, develop, validate, and troubleshoot statistical or mathematical based machine learning models using the Python programming language, thoroughly testing the models to ensure output with maximum accuracy and reliability.	C, An, E	7,6,8,10
5	Apply advanced Python programming techniques and packages to develop sophisticated and efficient research methodologies on applications, exploring various libraries and leveraging their capabilities	C, U, A	7,9,10
*Remer	nber (R). Understand (U). Apply (A). Analyse (An). Evaluate (E).	Create (C). S	Skill (S)

Unit	Course description	Hrs	CO No.
Unit I	Data and Data Management: Sources of Data -		
	Primary, Secondary, and Tertiary – Types of Data	16	1
	– Categorical, Nominal and Ordinal, Data cleaning		
	and noise removal.		
Unit II	Introduction to Python programming- Working	20	2
	with Python- Basic Syntax-Variables and Data		
	Types-Operators, Data Representation, Basic Data		
	operations, Arrays and Plotting.		
Unit III	Conditional Statements- Loops-Functions-Lists &	24	3
	Dictionaries, Computing with Formulas,		
	Functions and Branching, User input and Error		
	Handling Modules.		
Unit IV	Machine Learning models: Classification and	24	4
	Regression Training and testing models:		
Unit V	Advanced Python Programming Techniques,	16	5
	Packages, Libraries, Sophisticated and Efficient		
	Python applications, Introduction to Pre-trained		
	Research Models		

Scheme and Syllabi in OBE Framework effective from 2021 Admission onwards (Based on CSS 2020 Regulations)



COM21032 PYTHON PROGRAMMING FOR SCIENTIFIC RESEARCH

Teaching and	Classroom Procedure (Mode of transaction)
Learning	Direct Instruction: Explicit Teaching, E-learning
Approach	Interactive Instruction: Active co-operative learning, Seminar, Group
	Assignments
	Authentic learning: Library work and Group discussion, Presentation by
	individual student/Group representative.
Assessment	Mode of Assessment
Types	A. Continuous Internal Assessment (CIA)
	• Internal Tests – Minimum two (Extended answers)
	• Seminar –
	 Research Literature review
	 Report writing
	 Presentation
	• Assignments – Written, Oral presentation and viva.
	• Case study
	B. Semester End Examination

REFERENCES

- 1 C.R.Kothari, "Research Methodology", New Age International Publishers.
- 2 Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd.
- 3 Peter Norton & Alex Samuel, "Beginning Python", David Aitel-wrox publications.
- 4 Dr. Pratiyush Guleria, "Basics of Python Programming" BPB Publications.
- 5 Joakim Sundnes, "Introduction to Scientific Programming with Python", Simula, Springer.