VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

School of Computer Science and Engineering

CURRICULUM AND SYLLABI

(2023-2024)

M. Tech. Computer Science and Engineering - 5 year Integrated [In Collaboration with Virtusa]

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VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- **World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.
- **Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.
- **Impactful People**: Happy, accountable, caring and effective workforce and students.
- **Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.
- **Service to Society**: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

- To be a world-renowned centre of education, research and service in computing and allied domains.

MISSION STATEMENT OF THE SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

- To offer computing education programs with the goal that the students become technically competent and develop lifelong learning skill.

- To undertake path-breaking research that creates new computing technologies and solutions for industry and society at large.

- To foster vibrant outreach programs for industry, research organizations, academia and society.

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M. Tech. Computer Science and Engineering - 5 year Integrated [In Collaboration with Virtusa]

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduate will acquire fundamental knowledge and expertise essential for professional practice in computer engineering.
2. Graduates will use suitable principle, hypothesis, mathematics and computational technology to analyze and solve problems encountered in the applications of computer systems.
3. Graduates will own a professional attitude as an individual or a team member with contemplation for society, professional ethics, environmental factors and motivation for lifelong learning.
4. Graduates will communicate, using oral, written and computer-based communication technology, as well as function effectively as an individual and a team member in professional environment.
5. Graduates will realize the local, national and global issues related to the growth and applications of computer systems and to be solicitous of the impact of these issues on different cultures.

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PROGRAMME OUTCOMES (POs)

- PO_1 Having an ability to apply mathematics and science in engineering applications.
- PO_2 Having a clear understanding of the subject related concepts and of contemporary issues.
- PO_3 Having an ability to design a component or a product applying all the relevant standards and with realistic constraints.
- PO_4 Having an ability to design and conduct experiments, as well as to analyze and interpret data.
- PO_5 Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice.
- PO_6 Having problem solving ability-solving social issues and engineering problems.
- PO_7 Having adaptive thinking and adaptability.
- PO_8 Having a clear understanding of professional and ethical responsibility.
- PO_9 Having cross cultural competency exhibited by working in teams.
- PO_10 Having a good working knowledge of communicating in English.
- PO_11 Having a good cognitive load management [discriminate and filter the available data] skills.
- PO_12 Having interest in lifelong learning.

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PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Apply knowledge of recent computing technologies, skills and current tools of computer science and engineering.
2. Acquire proficiency in Front-end design, expertise in server side frameworks and Data-exchange technologies in the direction of full stack Engineers.
3. Apply technological advancements in end to end industry ready projects and computing skills to carry out research in emerging areas.

CREDIT INFO		
S.no	**Catagory**	**Credits**
1	Programme Core	81
2	Programme Elective	62
3	University Core	65
4	University Elective	12
5	Bridge Course	0
6	Non Credit Course	5
Total Credits		225

Programme Core									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	CSE2010	Advanced C Programming	Embedded Theory and Lab	1.0	2	0	2	0	3.0
2	CSI1001	Principles of Database Systems	Embedded Theory and Lab	1.0	2	0	2	0	3.0
3	CSI1002	Operating System Principles	Embedded Theory and Lab	1.0	2	0	2	0	3.0
4	CSI1003	Formal Languages and Automata Theory	Theory Only	1.0	3	0	0	0	3.0
5	CSI1004	Computer Organization and Architecture	Theory Only	1.0	3	0	0	0	3.0
6	CSI1007	Software Engineering Principles	Embedded Theory and Lab	1.0	2	0	2	0	3.0
7	CSI2001	Digital logic and Computer Design	Embedded Theory and Lab	1.0	3	0	2	0	4.0
8	CSI2002	Data Structures and Algorithm Analysis	Embedded Theory and Lab	1.0	3	0	2	0	4.0
9	CSI2003	Advanced Algorithms	Embedded Theory and Lab	1.0	2	0	2	0	3.0
10	CSI2004	Advanced Database Management Systems	Theory Only	1.0	3	0	0	0	3.0
11	CSI2005	Principles of Compiler Design	Theory Only	1.0	3	0	0	0	3.0
12	CSI2006	Microprocessor and Interfacing Techniques	Embedded Theory and Lab	1.0	2	0	2	0	3.0
13	CSI2007	Data Communication and Networks	Embedded Theory and Lab	1.0	3	0	2	0	4.0
14	CSI2008	Programming in Java	Embedded Theory and Lab	1.0	3	0	2	0	4.0
15	CSI3001	Cloud Computing Methodologies	Embedded Theory and Lab	1.0	3	0	2	0	4.0
16	CSI3002	Applied Cryptography and Network Security	Embedded Theory and Lab	1.0	2	0	2	0	3.0
17	CSI3003	Artificial Intelligence and Expert Systems	Theory Only	1.0	3	0	0	0	3.0
18	CSI3023	Advanced Server Side Programming	Embedded Theory and Lab	1.0	2	0	2	0	3.0
19	CSI3024	Software Application Architecture	Theory Only	1.0	3	0	0	0	3.0

Programme Core									
20	CSI3025	Application Development and Deployment Architecture	Embedded Theory and Lab	1.0	2	0	2	0	3.0
21	CSI3026	Machine Learning	Embedded Theory and Lab	1.0	2	0	2	0	3.0
22	CSI3029	Front End Design and Testing	Embedded Theory and Lab	1.0	2	0	2	0	3.0
23	EEE1024	Fundamentals of Electrical and Electronics Engineering	Embedded Theory and Lab	1.0	2	0	2	0	3.0
24	MAT1014	Discrete Mathematics and Graph Theory	Theory Only	1.1	3	2	0	0	4.0
25	MAT1022	Linear Algebra	Theory Only	1.0	3	0	0	0	3.0

Programme Elective									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	CSI3005	Advanced Data Visualization Techniques	Embedded Theory and Lab	1.0	3	0	2	0	4.0
2	CSI3006	Soft Computing Techniques	Embedded Theory and Project	1.0	3	0	0	4	4.0
3	CSI3007	Advanced Python Programming	Embedded Theory and Lab	1.0	2	0	4	0	4.0
4	CSI3008	Internet of Everything	Embedded Theory and Lab	1.0	3	0	2	0	4.0
5	CSI3009	Advanced Wireless Networks	Embedded Theory and Lab	1.0	3	0	2	0	4.0
6	CSI3010	Data Warehousing and Data Mining	Embedded Theory and Lab	1.0	3	0	2	0	4.0
7	CSI3011	Computer Graphics and Multimedia	Embedded Theory and Lab	1.0	3	0	2	0	4.0
8	CSI3012	Distributed Systems	Embedded Theory and Lab	1.0	3	0	2	0	4.0
9	CSI3013	Blockchain Technologies	Embedded Theory and Project	1.0	3	0	0	4	4.0
10	CSI3014	Software Verification and Validation	Theory Only	1.0	3	0	0	0	3.0
11	CSI3015	Software Project Management	Theory Only	1.0	3	0	0	0	3.0
12	CSI3016	Robotics: Machines and Controls	Theory Only	1.0	3	0	0	0	3.0
13	CSI3019	Advanced Data Compression Techniques	Theory Only	1.0	3	0	0	0	3.0
14	CSI3020	Advanced Graph Algorithms	Theory Only	1.0	3	0	0	0	3.0
15	CSI3021	Advanced Computer Architecture	Theory Only	1.0	3	0	0	0	3.0
16	CSI3022	Cyber Security and Application Security	Embedded Theory and Lab	1.0	3	0	2	0	4.0
17	CSI3027	R Programming	Embedded Theory and Lab	1.0	2	0	2	0	3.0
18	CSI3028	Deep Learning	Theory Only	1.0	3	0	0	0	3.0
19	CSI3030	Internetworking with TCP/IP	Theory Only	1.0	3	0	0	0	3.0

Programme Elective									
20	CSI3031	Quantum Computing Techniques	Theory Only	1.0	3	0	0	0	3.0
21	CSI3032	Advances in Pervasive Computing	Theory Only	1.0	3	0	0	0	3.0
22	CSI3033	Web Mining and Social Network Analysis	Embedded Theory and Project	1.0	3	0	0	4	4.0
23	CSI4001	Natural Language Processing and Computational Linguistics	Embedded Theory and Project	1.0	3	0	0	4	4.0
24	CSI4002	Logic and Combinatorics for Computer Science	Theory Only	1.0	3	0	0	0	3.0
25	CSI4003	Computer Oriented Numerical Methods	Embedded Theory and Lab	1.0	3	0	2	0	4.0
26	CSI4004	Text Mining	Theory Only	1.0	3	0	0	0	3.0
27	CSI4005	Augmented Reality and Virtual Reality	Embedded Theory and Project	1.0	3	0	0	4	4.0
28	CSI4006	Game Theory	Theory Only	1.0	3	0	0	0	3.0
29	CSI4007	GPU Programming	Theory Only	1.0	3	0	0	0	3.0
30	CSI4008	Programming Paradigms	Embedded Theory and Lab	1.0	3	0	2	0	4.0
31	CSI4009	Mathematical Modelling and Simulation	Theory Only	1.0	3	0	0	0	3.0
32	CSI4010	Cognitive Science and Decision Making	Theory Only	1.0	3	0	0	0	3.0
33	MAT2002	Applications of Differential and Difference Equations	Embedded Theory and Lab	1.0	3	0	2	0	4.0
34	MDI3002	Foundations of Data Science	Theory Only	1.0	3	0	0	0	3.0
35	MDI3003	Advanced Predictive Analytics	Embedded Theory and Lab	1.0	3	0	2	0	4.0
36	MDI3007	Fault Tolerant Computing System	Theory Only	1.0	3	0	0	0	3.0
37	MDI4012	Vision and Image Processing	Embedded Theory and Lab	1.0	3	0	2	0	4.0

University Core									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	CHY1701	Engineering Chemistry	Embedded Theory and Lab	1.0	3	0	2	0	4.0
2	CSE1001	Problem Solving and Programming	Lab Only	1.0	0	0	6	0	3.0
3	CSE1002	Problem Solving and Object Oriented Programming	Lab Only	1.0	0	0	6	0	3.0
4	CSI1006	Mini Project	Project	1.0	0	0	0	0	4.0
5	CSI3901	Technical Answers for Real World Problems (TARP)	Embedded Theory and Project	1.0	1	0	0	4	2.0
6	CSI3902	Comprehensive Examination	Project	1.0	0	0	0	0	1.0
7	CSI3903	Industrial Internship	Project	1.0	0	0	0	0	1.0
8	CSI4901	Capstone Project	Project	1.0	0	0	0	0	18.0
9	ENG1901	Technical English - I	Lab Only	1.0	0	0	4	0	2.0

University Core									
10	ENG1902	Technical English - II	Lab Only	1.0	0	0	4	0	2.0
11	ENG1903	Advanced Technical English	Embedded Lab and Project	1.0	0	0	2	4	2.0
12	FLC4097	Foreign Language Course Basket	Basket	1.0	0	0	0	0	2.0
13	HUM1021	Ethics and Values	Theory Only	1.2	2	0	0	0	2.0
14	MAT1011	Calculus for Engineers	Embedded Theory and Lab	1.0	3	0	2	0	4.0
15	MAT2001	Statistics for Engineers	Embedded Theory and Lab	1.1	3	0	2	0	4.0
16	MGT1022	Lean Start-up Management	Embedded Theory and Project	1.0	1	0	0	4	2.0
17	PHY1701	Engineering Physics	Embedded Theory and Lab	1.0	3	0	2	0	4.0
18	PHY1901	Introduction to Innovative Projects	Theory Only	1.0	1	0	0	0	1.0
19	STS5097	Soft Skills M.Tech SE (5 Yr.) / M.Sc.Biotechnology (5 Yr.)	Basket	1.0	0	0	0	0	8.0

Bridge Course									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	ENG1000	Foundation English - I	Lab Only	1.0	0	0	4	0	2.0
2	ENG2000	Foundation English - II	Lab Only	1.0	0	0	4	0	2.0

Non Credit Course									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	CHY1002	Environmental Sciences	Theory Only	1.1	3	0	0	0	3.0
2	EXC4097	Co-Extra Curricular Basket	Basket	1.0	0	0	0	0	2.0

CSE2010	Advanced C Programming	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. In depth understanding of storage classes, memory allocation and pointer manipulation.
2. High level and low level organization of files.
3. Explore the power of macros and preprocessor directives.

Expected Course Outcome:

At the end of this course students will be able to:

- Learn various control structures and derived data types for solving real world problems using user defined functions.
- Explore dynamic memory allocations strategies and user defined data types.
- Realize the features of various Input and Output methods including files.
- Idealize the power of preprocessor directives and recognize programming methods
- Able to modularize the programming using various input, output, mathematical and utility functions in C and unix system interfaces.
- Able to design the software in c using features of graphics, embedded programming concepts.
- Apply the learned concepts and design algorithmic solutions for the real world problems.

Module:1	Control Structures, Functions and Pointer	3 hours

Review of C fundamentals : Data types, Operators and Expressions, Control structures, Arrays, Functions, String, Pointers and Structures.

Module:2	Memory Allocation	5 hours

The memory layout in c programming, dynamic memory allocation: malloc(), calloc(), realloc(), free(), core dump, memory leak, dangling pointer. Pointers and array: Pointer and one dimensional arrays, Array of pointers, Pointers and two dimensional arrays, Subscripting pointer to an array, Dynamic 1D and 2D array.

Module:3	User defined data types	5 hours

Structures, array of structures, passing structure to functions, function pointers : Passing and returning values using pointers, Array as function argument, Using Pointers as Arguments, Functions returning address, Function returning pointers, Pointer to a function, Calling a function through function pointer, Functions with varying number of arguments. arrays and structures within structures, Unions, Bit fields, enumerations, typedef.

Module:4	Input/Output Manipulation and Files	5 hours

I/O Manipulation: Standard I/O, Formatted Output - printf, Formated Input - scanf, Variable length argument list, file access including FILE structure, fopen, stdin, sdtout and stderr, Error Handling including exit, perror and error.h, Line I/O, related miscellaneous functions. Files manipulations: File Descriptors, File pointer, Working with text files, working with binary files, Character I/O, EOF, Sequential and random access.

Module:5	Preprocessor Directives and programming method	4 hours

Preprocessor Directives: #include statements, #define statements, #error, Conditional compilation, #undef, The # and ## preprocessor operators, Predefined macro names, Nested

macros, Multiline macros, Macros pitfalls, Macros Vs enums, Inline functions, Macros vs inline functions, Inline recursive functions, Command line arguments, Environment Variables in C Programs, Type qualifiers. Programming Method: Debugging, User Defined Header, User Defined Library Function, makefile utility.		
Module:6	**Standard Library functions and Unix system Interface**	**3 hours**
Standard Library functions: I/O functions, string and character functions, mathematical functions, time, date and localization functions, utility functions, wide-character functions. Unix system Interface: File Descriptor, Low level I/O - read and write, Open, create, close and unlink, Random access - Iseek, Discussions on Listing Directory, Storage allocator.		
Module:7	**Graphics, embedded C and Software development using C**	**3 hours**
Graphics: writing a text graphics program, writing a pixel graphics program, two dimensional graphics. Embedded C programming : Basics, Data types, keywords, programming structure, basic embedded c programming. Software development using c: Building a windows 2000 skeleton, software engineering using c, efficiency, porting programming.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Byron Gottfried and JitenderChhabra , "Programming with C (Schaum's Outlines Series)", Third Edition. McGraw Hill Education. ISBN: 978-0070145900, July 2017.
2.	Herbert Schildt., "C: The Complete Reference", Fourth Edition. McGraw Hill Education. 978-0070411838. July 2017.
3.	Brian W. Kernighan and Dennis Ritchie, "The C Programming Language", Pearson Education India; 2nd Edition. ISBN: 978-9332549449. 2015.
4.	Peter Prinz and Tony Crawford, "C in a Nutshell: The Definitive Reference". O'Reilly Media. Inc., Second Edition. ISBN: 978-1491904756. December 2015.
5.	K R. Venugopal, Sudeep. R Prasad, "Mastering C", McGraw Hill Publishers, Second Edition. ISBN: 9789332901278. May 2015.
Reference Books	
1.	Jeff Szuhay, "Learn C Programming: A beginner's guide to learning C programming the easy and disciplined way", Packt Publishing Limited, First Edition, ISBN: 978-1789349917. June 2020.
2.	Zed A Shaw, "Learn C the Hard Way: Practical Exercises on the Computational Subjects You Keep Avoiding (Like C)", First Edition. Addison Wesley. ISBN: 978-0-321-88492-3. September 2015.
3.	Richard M. Reeses, "Understanding and Using C Pointers", First Edition. O'Reilly Publishers, ISBN: 9781449344184. January 2013.
4.	A.R. Bradley, "Programming for Engineers", Springer, Berlin, Heidelberg. First Edition. ISBN: 978-3-642-23303-6, 2011.
5.	A. Forouzan and Richard F. Gilberg, "Computer Science: A Structured Programming Approach Using C", CENGAGE LEARNING (RS), Third Edition.ISBN: 978-8131503638, 2007.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Experiments (Indicative)		
1.	Programs to demonstrate the use of various data types and storage classes.	2 hours
2.	Programs to understand various control structures.	2 hours

3.	Programs for Manipulating Arrays (One dimensional and Two dimensional)	4 hours
4.	Programs to understand memory allocations using pointers (simple and arrays)	2 hours
5.	Programs using pointers to arrays including strings (One dimensional and two dimensional)	6 hours
6.	Programs to explore different kinds of macros.	2 hours
7.	Programs to manipulate different records (employee, students, HR) using structures (with and without pointers)	6 hours
8.	Programs to manipulate different files (sequential and random)	6 hours
	Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	09-09-2020		
Approved by Academic Council	No. 59	Date	24-09-2020

CSI1001	Principles of Database Systems	L	T	P	J	C
		2	0	2	0	3
Pre-requisite		Syllabus version				
		1.0				

Course Objectives:

1. To understand the basic concepts of DBMS and ER Modeling.
2. To comprehend the concepts normalization, query optimization and relational algebra.
3. To apply the concurrency control, recovery, security and indexing for the existent domain problems.

Expected Course Outcome:

1. Acquire a good understanding of the architecture and functioning of database management systems
2. Ability to construct an ER model, derive the relational schemas from the model
3. Analyze and improve a database design by normalization.
4. Ability to associate the basic database storage structure and access techniques including B Tree and B+ Tress
5. Analyze the basics of query evaluation and heuristic query optimization techniques.
6. Learn concepts of concurrency control for the desirable database problem.
7. Analyze the fundamental concepts of recovery mechanisms and learn the recent trends in database.

Module:1	DATABASE SYSTEMS CONCEPTS AND ARCHITECTURE	4 hours

Need for Database Systems – Characteristics of Database Approach – Actors in DBMS- Database Administrator - Data Models – Relational, Hierarchical and Network models - Schemas, and Instances - Three-Schema Architecture - The Database System Environment – Overall System Structure/Architecture – Querying- Query Languages - Relational Algebra - Relational Calculus

Module:2	DATA MODELING	4 hours

Entity Relationship Model: Types of Attributes, Relationship, Structural Constraints – Relational Model, Relational Model Constraints – Mapping ER model to a Relational Schema – Integrity Constraints-Extended E-R model - Generalisation – Specialization - Aggregation

Module:3	DATABASE DESIGN	5 hours

Guidelines for Relational Schema - Functional Dependency; Normalization, Boyce Codd Normal Form, Multi-valued Dependency and Fourth Normal Form; Join Dependency and Fifth Normal Form

Module:4	QUERY PROCESSING AND TRANSACTION PROCESSING	5 hours

Translating SQL Queries into Relational Algebra – Heuristic Query Optimization – Introduction to Transaction Processing – Transaction and System Concepts - Desirable Properties of Transactions – Characterizing Schedules based on Recoverability – Characterizing Schedules based on Serializability - Test for Serializability - Need for Locking - Compatibility Matrix for Locks - Deadlocks in Transactions.

Module:5	PHYSICAL DATABASE DESIGN	5 hours

File Organization - RAID devices - Indexing: Single Level Indexing, Multi-level Indexing, Dynamic Multilevel Indexing , Indexing on Multiple Keys – B-Tree Indexing – B+ Tree Indexes - Hashing - Static and Dynamic Hashing.

Module:6	CONCURRENCY CONTROL	3 hours

Lock based protocols - Two-Phase Locking - Graph based Protocols - Tree Protocol - Techniques for Concurrency Control - Concurrency Control based on Timestamp based protocols.

Module:7	**RECOVERY TECHNIQUES**	**2 hours**
Recovery Concepts - Recovery based on Deferred Update - Recovery Techniques based on Immediate Update – Shadow Paging – Distributed databases - Distributed Transactions – Commit Protocols		
Module:8	**CONTEMPORARY ISSUES**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	R. Elmasri & S. B. Navathe, Fundamentals of Database Systems, Addison Wesley, 7th Edition, 2016.
2.	A. Silberschatz, H. F. Korth& S. Sudershan, Database System Concepts, McGraw Hill, 7th Edition 2019.
Reference Books	
1.	Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", Fourth Edition, Tata McGraw Hill, 2015.
2.	Thomas Connolly, Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation and Management,6thEdition,Pearson,2015
3.	C. J. Date, A. Kannan, S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006
Mode of Evaluation:CAT/ Digital Assignment/Quiz/FAT/ Project.	

List of Experiments		
1.	SQL tool, Data types in SQL, Creating Tables (along with Primary and Foreign keys), Altering Tables and Dropping Tables	3 hours
2.	Practice Queries using COUNT, SUM, AVG, MAX, MIN, GROUP BY, HAVING, VIEWS Creation and Dropping.	3 hours
3.	Practicing Sub queries (Nested, Correlated) and Joins (Inner, Outer and Equi)	3 hours
4.	Practicing Queries using ANY, ALL, IN, EXISTS, NOT EXISTS, UNION, INTERSECT, CONSTRAINTS etc.	3 hours
5.	Iterations using For Loop,While Loop and Do while	3 hours
6.	Declaring Cursor, Opening Cursor, Fetching the data, closing the curso	3 hours
7.	Creation of Stored Procedures, Execution of Procedure, and Modification of Procedure	3 hours
8.	Practicing User Defined Exceptionand System Defined Exception	3 hours
9.	Creation of trigger, Insertion using trigger, Deletion using trigger, Updating using trigger	3 hours
10.	Database Application development	3 hours
	Total Laboratory Hours	**30 hours**
Mode of assessment: Assessment Examination, FAT Lab Examination		

Recommended by Board of Studies	16-09-2020		
Approved by Academic Council	No. 59	Date	24-09-2020

CSI1002	Operating System Principles	L	T	P	J	C
		2	0	2	0	3
Pre-requisite		Syllabus version				
		1.0				

Course Objectives:

1. To introduce Operating system concepts, designs and provide the skills required to implement the services.
2. To understand the structure and organization of the file system.
3. To understand what a process is and how processes are synchronized and scheduled.
4. To understand different approaches of memory management, system call for managing process and file system.

Expected Course Outcome:

Upon completion of the course, the students will be able to

1. Gain extensive knowledge on principles and modules of operating systems
2. Interpret the evolution of OS functionality, structures, layers and different system calls to find the stages of various process states.
3. Design a model scheduling algorithm to compute various scheduling criteria.
4. Apply and analyze communication between inter process and synchronization techniques.
5. Implement page replacement algorithms, memory management and to apply the file system techniques.
6. Representing virtualization and demonstrating the various Operating system tasks and the principle algorithms for enumerating those tasks.

Module:1	Introduction	4 hours

Computer-System Organization, Computer-System Architecture, Operating-System Structure (monolithic, layered, modular, micro-kernel models), Operating-System Operations, Operating-System Services, User and Operating- System Interface, System Calls.

Module:2	Processes	4 hours

Process Concept, Operations on Processes, Inter-process Communication, Threads - Overview, Multithreading Models.

Module:3	CPU Scheduling	4 hours

Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Threads, Multiple-Processor Scheduling, Deadlocks- System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

Module:4	Process Synchronization	4 hours

Background, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors, Synchronization Example.

Module:5	Memory Management	4 hours

Introduction, Swapping, Contiguous Memory Allocation, Segmentation, Paging, structure of the Page Table.

Module:6	Virtual Memory	4 hours

Background, Demand Paging, Page Replacement, Allocation of Frames, Thrashing, Introduction to Virtualization.

Module:7	Mass-Storage Structure	4 hours

Overview, Disk Structure, Disk Scheduling. File -System Interface - File Concept, Access Methods, Directory and Disk Structure, Directory Implementation, Allocation Methods. Future directions in Mobile OS.

Module:8	Recent Trends	2 hours

	Total Lecture hours:			**30 hours**
Text Book(s)				
1.	A.Silberschatz, P. B. Galvin & G. Gagne, Operating system concepts, Ninth Edition, John Wiley, 2018.			
Reference Books				
1.	W. Stallings, Operating Systems-Internals and Design Principles, Seventh Edition, Prentice- Hall,2012.			
2.	Andrew.S Tanenbaum & Herbert Bos, Modern Operating Systems, Fourth Edition, Prentice Hall,2015.			
3.	Remzi H. Arpaci-Dusseau, Andrea C. Arpaci-Dusseau, Operating Systems, Three Easy Pieces, Arpaci-Dusseau Books, Inc (2015).			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Experiments				
1.	Study of Linux commands – System Information, Files and Directories, Process, Text Processing and Scripting, Programming.			3 hours
2.	Shell scripting (I/O, decision making, looping)			3 hours
3.	Creating Child process (using fork), Zombie, Orphan. Displaying system information using C.			3 hours
4.	CPU Scheduling Algorithms (FCFS, SJF, RR, Priority)			3 hours
5.	Deadlock Avoidance Algorithm (Bankers algorithm)			3 hours
6.	IPC (Threads, Pipes)			3 hours
7.	Process synchronization (Producer Consumer / Reader Writer/Dining Philosopher using semaphores)			3 hours
8.	Dynamic Memory Allocation Algorithms (First fit, Best fit, Worst fit)			3 hours
9.	Page Replacement Algorithms. (FIFO, LRU, Optimal)			3 hours
10.	Disk Scheduling Algorithms.			3 hours
			Total Laboratory Hours	**30 hours**
Mode of evaluation:				
Recommended by Board of Studies	16-09-2020			
Approved by Academic Council	No. 59	Date	24-09-2020	

CSI1003	Formal Languages and Automata Theory	L	T	P	J	C
		3	0	0	0	3
Pre-requisite		**Syllabus version**				
		1.0				

Course Objectives:

The objective of this course is to learn
1. Types of grammars and models of automata.
2. Limitation of computation: What can be and what cannot be computed.
3. Establishing connections among grammars, automata and formal languages and realize the theoretical concepts and techniques involved in the software system development

Expected Course Outcome:

After successfully completing the course the student should be able to
1. Model, compare and analyse different computational models
2. Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
3. Identify limitations of some computational models and possible methods of proving them.
4. Explain the abstract concepts mathematically with notations

Module:1	**Introduction to Languages and Grammars**	**4 hours**

Recall on Proof techniques in Mathematics - Overview of a Computational Models - Languages and Grammars - Alphabets - Strings - Operations on Languages, Overview on Automata

Module:2	**Finite State Automata**	**8 hours**

Finite Automata (FA) - Deterministic Finite Automata (DFA) - Non-deterministic Finite Automata (NFA) - NFA with epsilon transitions – NFA without epsilon transition, conversion of NFA to DFA, Equivalence of NFA and DFA – minimization of DFA

Module:3	**Regular Expressions and Languages**	**7 hours**

Regular Expression - FA and Regular Expressions: FA to regular expression and regular expression to FA - Pattern matching and regular expressions - Regular grammar and FA - Pumping lemma for regular languages - Closure properties of regular languages, linear grammars and linear languages.

Module:4	**Context Free Grammars**	**7 hours**

Context-Free Grammar (CFG) – Derivations - Parse Trees - Ambiguity in CFG - CYK algorithm – Simplification of CFG – Elimination of Useless symbols, Unit productions, Null productions - Normal forms for CFG: CNF and GNF - Pumping Lemma for CFL - Closure Properties of CFL, context-sensitive grammars definition and examples

Module:5	**Pushdown Automata**	**5 hours**

Definition of the Pushdown automata - Languages of a Pushdown automata – Power of Non-Deterministic Pushdown Automata and deterministic pushdown automata

Module:6	**Turing Machine**	**6 hours**

Turing Machines as acceptor and transducer - Multi head and Multi tape Turing Machines – Universal Turing Machine - The Halting problem - Turing-Church thesis

Module:7	**Recursive and Recursively Enumerable Languages**	**6 hours**

Recursive and Recursively Enumerable Languages, Language that is not Recursively Enumerable (RE) – computable functions – Chomsky Hierarchy – Undecidable problems - Post's Correspondence Problem

Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. John C. Martin, "Introduction to Languages and the Theory of Computation", Fourth Edition, Mcgraw-hill Higher Education Publishers, 2010.
2. Peter Linz, "An Introduction to Formal Language and Automata", Fourth Edition,

	Narosa Publishers, New Delhi, 2013.		
Reference Books			
1.	K. Krithivasan and R. Rama, "Introduction to Formal Languages, Automata and Computation", Pearson Education, 2009.		
2.	J.E. Hopcroft, R. Motwani and J.D. Ullman, "Introduction to Automata Theory, Languages and Computations", Third Edition, Pearson Education, 2014.		
3.	Micheal Sipser, Introduction of the Theory and Computation, Third Edition, Thomson Brokecole Cengage Learning, 2012.		
4.	Dexter C. Kozen, "Automata and Computability", Springer Publishers, 2012.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	16-09-2020		
Approved by Academic Council	No. 59	Date	24-09-2020

CSI1004	Computer Organization And Architecture	L	T	P	J	C
		3	0	0	0	3
Pre-requisite		**Syllabus version**				
		1.0				

Course Objectives:

1. To familiarize students with the fundamental components, architecture, register organization and performance metrics of a computer.
2. To make students capable for understanding and analyzing the effects of each instruction execution and the data path in those instruction execution.
3. To impart the knowledge of data representation in binary and understand implementation of arithmetic algorithms in a typical computer.
4. To make students understand the importance of memory systems, IO interfacing techniques and external storage and their performance metrics for a typical computer.

Expected Course Outcome:

1. Understand the general architecture of a computer system and the instruction based architecture.
2. Illustrate various binary data representations for fixed and floating point data. Validate efficient algorithm for arithmetic operations.
3. Explain the importance of hierarchical memory organization. Able to construct larger memories. Analyze and suggest efficient cache mapping technique and replacement algorithms for given design requirements. Get the idea about different external storage devices.
4. Understand the need for an interface. Compare and contrast memory mapping and IO mapping techniques. Describe and Differentiate different modes of data transfer. Appraise the synchronous and asynchronous bus for performance and arbitration.
5. Understand some system performance enhancement techniques such as pipeline concepts, parallel execution, etc. Introduction to some of the advanced architectures.

Module:1	Introduction to computer architecture	4 hours

Introduction to computer systems - Overview of Organization and Architecture – Components, Registers and register files, Connections – Von Neumann machine (IAS Machine) – Architecture – Communication between components

Module:2	Instruction Set Architecture	6 hours

Introduction to ISA (Instruction Set Architecture): Instruction formats - Instruction types - Addressing modes - Instruction cycle – Introduction to Assembly Language Programming.

Module:3	Data Representation And Computer Arithmetic	9 hours

Data Representation – Introduction to Fixed point representation of numbers - Floating point representation of numbers (IEEE standard representation) - Algorithms for fixed point arithmetic operations: Addition, Subtraction, Multiplication (Booth's Algorithm), Division - Representation of non-numeric data (character codes).

Module:4	Memory System Organization & Architecture	10 hours

Memory systems hierarchy - Main memory organization – Byte ordering - Memory interleaving - Memory characteristics - Cache memories: Introduction - Parameters of Cache memory - Address mapping – Read and write policies - Cache Coherence - Virtual memory systems - TLB - Page replacement Algorithms.

Module:5	Interfacing and Communication I/O fundamentals	7 hours

I/O fundamentals: I/O Modules, I/O mapped I/O and Memory Mapped I/O - Introduction to I/O techniques: Programmed I/O, Interrupt-driven I/O, DMA - Interrupt structures: Interrupt cycle, Subroutine call and return mechanisms - Bus System: Synchronous and asynchronous buses, Bus Arbitration.

Module:6	Device Subsystems	4 hours

External storage systems - Organization and structure of disk drives: Electronic, Magnetic and

optical technologies - RAID Levels - I/O Performance			
Module:7	**Performance Enhancements**		**4 hours**
Classification of models - Flynn's taxonomy of parallel machine models (SISD, SIMD, MISD, MIMD) - Introduction to data path - Introduction to Pipelining - Pipelined data path - Introduction to hazards.			
Module:8	**Recent Trends**		**1 hour**
	Total Lecture hours:		**45 hours**
Text Book(s)			
1.	Patterson, D.A.,Hennessy, J. L. *Computer organization and design:The Hardware/software interface RISC-V edition* Morgan Kaufmann, 2017.		
2.	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer organization, Mc Graw Hill, Fifth edition, Reprint 2011.		
Reference Books			
1.	Mano, M. Morris. *Computer system architecture*. Prentice-Hall of India, 3rd Edition, 2003.		
2.	Computer Architecture and Organization by William Stallings, PHI Pvt. Ltd., Eastern Economy Edition, Sixth Edition, 2003		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	16-09-2020		
Approved by Academic Council	No. 59	Date	24-09-2020

CSI1007	Software Engineering Principles	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**Nil**	**Syllabus version 1.0**				

Course Objectives:

1.To introduce the essential software engineering concepts involved in developing software products and components
2. To impart development skills during design, implementation and testing of reliable software systems across various disciplines
3. To familiarize engineering practices and standards used in developing software products and components

Course Outcome:

1. Apply the principles of Software engineering methodology during software development and deployment process.
2. Document various processes like Requirement Engineering, Design and Testing.
3. Demonstrate an ability to use the techniques and tools necessary for significant application domains
4. Apply software testing and quality knowledge and engineering methods for various applications
5. Analyze the effectiveness of managing software projects through various techniques like Estimations, Scheduling and Quality Models
6. Apply benchmarking standards in process and in product.

Student Learning Outcomes (SLO):	**6,9,13**

Module:1	**Introduction**	**5 hours**

Software Engineering- Need, Importance and its characteristics - Software Process- Generic process model-Prescriptive process model-specialized, unified process-Agile development-Agile Process- Extreme Programming- Other agile Process models-Software engineering Knowledge-core Principles-Principles that guide each framework Activity.

Module:2	**Software Requirement Analysis**	**5 hours**

Requirements Engineering-Establishing the Groundwork-Eliciting Requirements- Developing use cases-Building the requirements model-Negotiating, validating Requirements-Requirements Analysis-Requirements Modeling Strategies.
Specifying Requirements: functional and non-functional requirements; specification exercise. Managing the Requirements Process: methods which provide a structure for co-operation between different stake holders. Prototyping: The role of prototyping in requirements techniques for prototyping. Requirements for Future Technologies: Computer Supported Co-operative Work (CSCW); networked multi-media systems.

Module:3	**Software Design**	**5 hours**

Design concepts and principles - Abstraction - Refinement - Modularity – Cohesion & coupling, Architectural design, Detailed Design – Transaction & Transformation, Refactoring of designs, Object-oriented Design User-Interface Design; Object Oriented Design Concepts and Diagrams - Use Case Diagrams - Class Diagrams - Interaction Diagrams - State chart Diagrams - Activity Diagrams - Package Diagrams - Component Diagrams – Deployment Diagrams

Module:4	**Software Implementation**	**4 hours**

Structured coding Techniques-Coding Styles-Standards and Guidelines- Documentation Guidelines-Modern Programming Language Features: Type checking-User defined data types-Data Abstraction-Exception Handling- Concurrency Mechanism – Seven Steps of implementing software – Implementation Challenges and its resolution.

Module:5	**Software Testing**	**4 hours**

TESTING: Introduction; Software Testing Fundamental; Testing Principles; Testing Levels;

Verification and Validation: Validation Testing, Validation Test Criteria; Test Plan: Test Documentation; Test Strategies: Top-Down Testing, Bottom-Up Testing, Thread testing, Stress testing, Back-to-back testing; Testing methods and tools: Testing through reviews, Black-box testing (Functional testing), White box testing (glass-box testing), Testing software changes; Additional requirements in testing OO Systems; Metrics Collection, Computation, and Evaluation; Test and QA plan; Managing Testing Functions.		
Module:6	**Software Maintenance**	**3 hours**
Software Maintenance, Types of Maintenance, Structured versus unstructured maintenance – Maintenance costs – Typical problems with maintenance and its side-effects – Maintenance process - Software Configuration Management – Component Reusability - Overview of RE-engineering & Reverse Engineering- Business Process Reengineering- Restructuring- Forward Engineering- Economics of Reengineering.		
Module:7	**Project Planning and Risk Management**	**2 hours**
Objectives of Activity planning – Project schedules – Activities – Sequencing and scheduling – Network Planning models – Forward Pass & Backward Pass techniques – Critical path (CRM) method – Risk identification – Assessment – Monitoring – PERT technique – Monte Carlo simulation – Resource Allocation – Creation of critical patterns – Cost schedules.		
Module:8	**Recent Trends**	**2 hours**
	Total Hours	**30 Hrs**
Lab Experiments		
1. Work Break-down Structure (Process Based, Product Based, Geographic Based and Role Based) 2. Estimations – Cost & Schedule 3. Entity Relationship Diagram, Context flow diagram, DFD (Structural Modeling and Functional Modeling) 4. State Transition Diagrams (Behavioral Modeling) 5. System Requirements Specification 6. UML diagrams for OO Design 7. Tools for Version Control 8. Black-box, White-box testing Non-functional testing		**30 Hrs**
Text Book(s)		
1.	Roger Pressman and Bruce Maxim, Software Engineering: A Practitioner's Approach, 9th Edition, McGraw-Hill, 2020.	
Reference Books		
1.	Ian Sommerville, Software Engineering, 10 th Edition, Addision-Wesley, 2015	
2.	Pankaj Jalote, An Integrated Approach to Software Engineering (Texts in Computer Science),Reprint Springer, 2010	
3.	William E. Lewis , "Software Testing and Continuous Quality Improvement", Third Edition, Auerbach Publications, 2008	
4.	David Gustafson , Schaum's Outline of Software Engineering,1st Edition, 2020	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar/Lab		
Recommended by Board of Studies	11-02-2021	
Approved by Academic Council	No. 61	Date 18-02-2021

CSI2001	DIGITAL LOGIC AND COMPUTER DESIGN	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To acquaint students with the basic concepts of digital and binary systems.
2. To analyze and design combinational and sequential logic circuits for real world applications.
3. To apply the theoretical concepts in designing the circuits using appropriate tools and hardwares.

Expected Course Outcomes:

Upon completion of the course, the students will be able to

1. Differentiate and represent the different types of number system.
2. Express and reduce the logic functions using Boolean Algebra and K-map.
3. Design minimal combinational logic circuits.
4. Analyze the operation of medium complexity standard combinational circuits like the encoder, decoder, multiplexer, demultiplexer.
5. Analyze and Design the Basic Sequential Logic Circuits
6. Outline the construction of Basic Arithmetic and Logic Circuits
7. Acquire design thinking capability, ability to design a component with realistic constraints, to solve real world engineering problems and analyze the results.

Student Learning Outcomes (SLO):	**2,5,14**

Module:1	**Introduction to Digital Logic**	**3 hours**
Number System, Base Conversion, Binary Codes, Complements, Logic gates, Universal gates, Positive and Negative Logic		
Module:2	**Boolean Algebra**	**6 hours**
Boolean algebra, Properties of Boolean algebra, Boolean functions, Canonical and Standard forms, Karnaugh map (up to 5 variables), Dont care conditions, Tabulation Method (up to 5 variables).		
Module:3	**Introduction To Combinational Circuit**	**6 hours**
Design of combinational circuits, Adder, Subtractor, Code Converter, Analyzing a Combinational Circuit.		
Module:4	**Design And Analyses Of Combinational Circuit**	**9 hours**
Binary Parallel Adder, Magnitude Comparator, Decoders, Encoders, Multiplexers, De-multiplexers.		
Module:5	**Sequential Circuits**	**7 hours**
Flip Flops, Conversion of Flip flops, Design and Analysis of Sequential circuits		
Module:6	**Design of Registers and Counters**	**6 hours**
Registers, Shift Registers, Bi-directional shift registers, Counters, Ripple and Synchronous Counters, Ring and Johnson counters.		
Module:7	**Arithmetic Logic Unit**	**6 hours**
Bus Organization, ALU, Design of ALU, Status Register, Design of Shifter.		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1. Morris Mano, M., 2016. Digital Logic and Computer Design. Pearson Education India. ISBN: 9789332542525.

Reference Books	
1. Malvino, A.P. and Leach, D.P. and GoutamSaha. 2014. Digital Principles and Applications (SIE). Tata McGraw Hill. ISBN: 9789339203405. 2. Morris Mano, M. and Michael D.Ciletti. 2014. Digital Design: With an introduction to Verilog HDL. Pearson Education. ISBN: 978-0132774208 3. Charles H. Roth Jr. 2013, Fundamentals of Logic Design, seventh Edition, Cl-Engineering. ISBN: 978-1133628477 4. John F. Wakerly, 2008. Digital Design Principles and Practices, Fourth Edition, Pearson Education. ISBN: 978-8131713662.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
List of Indicative Experiments	
1. 11	Realization of Logic gates using discrete components, verification of truth table for logic gates, realization of basic gates using NAND and NOR gates
2.	Implementation of Logic Circuits by verification of Boolean laws and verification of De Morgans.
3.	Adder and Subtractor circuit realization by implementation of Half-Adder and Full-Adder, and by implementation of Half-Subtractor and Full-Subtractor.
4.	Combinational circuit design i. Design of Decoder and Encoder ii. Design of Multiplexer and De multiplexer iii. Design of Magnitude Comparator iv. Design of Code Converter
5.	Sequential circuit design i. Design of Mealy and Moore circuit ii. Implementation of Shift registers iii. Design of 4-bit Counter iv. Design of Ring Counter.
6.	Implementation of different circuits to solve real world problems: A digitally controlled locker works based on a control switch and two keys which are entered by the user. Each key has a 2-bit binary representation. If the control switch is pressed, the locking system will pass the difference of two keys into the controller unit. Otherwise, the locking system will pass the sum of the two numbers to the controller unit. Design a circuit to determine the input to the controller unit.
7.	Implementation of different circuits to solve real world problems: A bank queuing system has a capacity of 5 customers which serves on first come first served basis. A display unit is used to display the number of customers waiting in the queue. Whenever a customer leaves the queue, the count is reduced by one and the count is increased by one if a customer joins a queue. Two sensors (control signals) are used to sense customers leaving and joining the queue respectively. Design a circuit that displays the number of customers waiting in the queue in binary format using LEDs. Binary 1 is represented by LED glow and 0 otherwise.
Total Laboratory Hours	**30 hours**

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	05.02.2020		
Approved by Academic Council	No. 61	Date	18.02.2021

CSI2002	Data Structures and Algorithm Analysis	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To provide the knowledge about linear and non-linear data structures
2. To provide the knowledge about algorithm analyses
3. To focus on the design of algorithms and data structure in various domains
4. To focus on various graph algorithms like shortest path algorithm, minimum spanning tree, etc.,
5. To provide familiarity with main thrusts of work in algorithms – sufficient to give some context for formulating and seeking known solutions to an algorithmic problem

Course Outcomes:

Upon completion of the course, the students will be able to

1. Solve real life computing problems by using data structures
2. Select the suitable data structures for storage and management of different types of data.
3. Apply the algorithm design techniques to analyze, solve and evaluate computing problems.
4. Analyze algorithms asymptotically and compute the performance analysis of algorithms with the same functionality.
5. Choose an appropriate design paradigm that solves the given problem efficiently along with appropriate data structures.
6. Solve complexities of problems in various domains

Student Learning Outcomes (SLO):	**1, 5, 9**

Module:1	**Introduction to Data Structures**	**5 hours**

Introduction to Data Structure, Importance of Data Structure, Types of Data Structures, Arrays, Structures, Union, Pointers, Storage Allocation: Static and Dynamic Allocation.

Module:2	**Analysis of Algorithms**	**5 hours**

Mathematical Background, Asymptotic Notations, Performance of the Algorithms: Time Complexity, Space Complexity, Master's Theorem.

Module:3	**Lists, Stacks and Queues**	**9 hours**

List: Definition, Operations–Implementation, Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists,Stack: Definition, Operations, Implementations, Applications: Recursion, Infix to Postfix and Evaluation of Postfix, Queue: Definition, Operations, Implementations, Applications: Circular Queue and Priority Queue.

Module:4	**Trees**	**6 hours**

Definition, Terminology, Binary Tree: Binary Tree Representation, Binary Search Tree, Binary Tree Traversal – Expression Tree, Finding K_{-th} element in Binary Tree, Tree to Binary tree conversion, Tree Traversal.

Module:5	**Hashing and Heaps**	**6 hours**

Hashing: General Idea, Hash Function, Hash Table, Collision in Hashing: Separate Chaining and Open Addressing- Rehashing. Heaps: Definition, Basic Operations, Min heap and Max heap Construction, Heap Sort.

Module:6	**Sorting**	**5 hours**

Preliminaries, Insertion Sort, Bubble Sort, Selection Sort, Shell Sort, Merge Sort, Quick Sort, Radix Sort

Module:7	**Graph Algorithms**	**7 hours**
Types of Graphs, Graph Representation, Shortest Path Algorithm: Dijikstra's Algorithm, FloyddWarshal's Algorithms, Graph Traversal, Minimum Spanning Tree		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s) and Journals	
1.	Mark Allen Weiss, "Data structures and algorithm analysis in C", 2nd edition, Pearson education, 2013.
Reference Books	
1.	DebasisSamanta, "Classic data structures", PHI, 2nd edition, 2014.
2.	Seymour Lipschutz "Data Structures by Schaum Series" 2nd edition,TMH 2013.
3.	Adam Drozdek, "Data structures and algorithms in C++", Cengage learning, 4th edition, 2015.
4.	Michael Goodrich, Roberto Tamassta, Michael H.GoldWasser "Data structures and algorithms in Java" 6th Edition, 2014.
	Authors, book title, year of publication, edition number, press, place
Mode of Evaluation: CAT / Assignment / Quiz / FAT / LAB / Seminar	
List of Indicative Experiments	
1.	Arrays , Loops and Structures
2.	Stack Implementations
3.	Stack Applications: Infix to postfix conversion, evaluation of postfix notation
4.	Queue and its applications
5.	Singly and doubly linked lists.
6.	Circular Singly Linked list
7.	Represent a polynomial as a linked list and write functions for polynomial addition.
8.	Insertion, Bubble, and selection sorts
9.	Merge and quick Sort
10.	Linear and Binary Search
11.	Binary tree. pre-order, in-order, and post-order traversals.
12.	Binary search tree insertion and deletion.
13,	Graph traversal
14.	Shortest Path Algorithm
Total Laboratory Hours	30 hours
Mode of assessment: CAT / Assignment / Quiz / FAT / Seminar	

Recommended by Board of Studies	05.02.2020		
Approved by Academic Council	No. 61	Date	18.02.2021

CSI2003	Advanced Algorithms	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**CSI2002 / CSE2003**	**Syllabus version**				
		1.0				

Course Objectives:

1. To focus on the design of algorithms in various domains
2. To provide a foundation for designing efficient algorithms.
3. To provide familiarity with main thrusts of work in algorithms- sufficient to give some context for formulating and seeking known solutions to an algorithmic problem.

Course Outcome:

1. Familiarize students with different algorithmic techniques
2. Apply advanced methods of designing and analyzing algorithms.
3. Choose appropriate algorithms and use it for a specific problem.
4. Understand different classes of problems concerning their computation difficulties.
5. Implement algorithm, compare their performance characteristics, and estimate their potential effectiveness in applications.

Student Learning Outcomes (SLO):	**1,5,14**	
Module:1	**Algorithm Design Techniques**	**5 hours**

Revisit of Greedy algorithms, divide-conquer, dynamic programming. Backtracking: General method, N-queen problem, Subset sum, Graph coloring, Hamiltonian cycles. Branch and Bound: General method, applications - Traveling sales person problem, 0/1 knapsack problem- LC Branch and Bound solution, FIFO Branch and Bound solution.

Module:2	**Network Flow**	**4 hours**

Flow Networks, Networks with multiple sources and sinks, Floyd-Warshall algorithm, Max Flow and Min Cut, Ford-Fulkerson Method and Edmonds-Karp Algorithm, Bipartite Matching.

Module:3	**Computational Complexity**	**5 hours**

Class complexity classes: P, NP, Reductions, NP-completeness and NP hard , NP-Complete Problems, CNF-SAT and 3SAT, Vertex-Cover and Clique

Module:4	**Randomized Algorithms**	**3 hours**

Las Vegas algorithms, Randomized Quick Sort, Monte Carlo algorithm, Primality Testing

Module:5	**Approximation Algorithms**	**4 hours**

Limits to Approximability, Bin Packing (First fit, Best fit),2 – Approximation algorithm for Metric TSP, Euclidean TSP, Max-SAT and Vertex Cover

Module:6	**Computational Geometry**	**4 hours**

Segment-intersection algorithm, Algorithms for finding convex hull: Graham's scan, Gift wrapping Algorithm. Finding the closest pair of points.

Module:7	**Algorithms for AI**	**3 hours**

Uninformed search, Heuristic search (8 queen and tiling problems), A* and AO* algorithms.

Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. T.H.Cormen, C.E.Leiserson, R.L.Rivest, and C.Stein, 'Introduction to algorithms',3rd Edition, MIT Press, 2009.
2. S. Sridhar, 'Design and Analysis of Algorithms', Oxford University Press, 2015. (Module 4 & 5).

Reference Books

1. M.T.Goodrich and R.Tomassia, 'Algorithm Design: Foundations, Analysis and Internet examples' , John Wiley and sons, 2011.
2. Sara Baase, Allen, Van, Gelder, 'Computer Algorithms, Introduction to Design and

3.	Analysis', 3rd Edition, Pearson Education., 2003. A.Levitin, 'Introduction to the Design and Analysis of Algorithms', Third Edition, Pearson Education, 2012.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Experiments		
1.	Implementation of algorithms for problems that can be solved by one or more of the following strategies: Divide and Conquer, Brute force, Greedy, Dynamic Programming. Branch-and-Bound algorithm for the 0-1 Knapsack problem to maximize the profit for a given problem instance.	6 hours
2.	Implementation of Graham's scan and Gift wrapping algorithms. In addition to that, using the implementation compare the running time of both the algorithms empirically by taking large input size range. Finally, compare empirical analysis and theoretical time complexity of both the algorithms.	4 hours
3.	Implementation of Ford-Fulkerson algorithm for computing a maximum flow in a network.	2 hours
4.	Randomized Algorithms: Las Vegas and Monte Carlo algorithms	2 hours
5.	Implementation of solution techniques for the minimum-cost flow problem.	2 hours
6	Heuristic search and A*, AO* algorithms	2 hours
7	Implementation of algorithms for Bin Packing, TSP, Vertex cover	4 hours
8	Implementation of search algorithms for graphs and trees: fundamental algorithms, Floyd Washall algorithm, Ford-Fulkerson Method and Edmonds-Karp Algorithm	6 hours
9	A simple polygon is defined as a flat shape consisting of straight non-intersecting line segments or sides that are joined pair –wise to from a closed path. Let P {p1, p2 , p3 ,....pn} be a set of points in the two dimensional plane. a. Write a program to find the simple polygon of P . b. Write a program (linear time) to convert that the simple polygon of P to a Convex Hull.	2 hours
	Total Laboratory Hours	**30 hours**
Mode of evaluation: Regular Assignments, Continuous Assessment Test / FAT (Lab)		
Recommended by Board of Studies	11-02-2021	
Approved by Academic Council	No. 61	Date 18-02-2021

CSI2004	Advanced Database Management Systems	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. To design conceptual and physical database tuning
2. To comprehend the concepts of parallel, distributed, multimedia and spatial database
3. To learn the concepts of mobile and cloud database
4. To understand the concepts of security and emerging technologies in database.

Course Outcome:

1. Acquire the concept of physical database design and tuning
2. Learn the concept of parallel and distributed database
3. Obtain the knowledge of multimedia and spatial database
4. Apply the concepts of mobile and cloud database in realtime applications
5. Distinguish various emerging database technologies and Analyze various security issues in databases

Student Learning Outcomes (SLO):	1, 5, 7	
Module:1	**Database Design Techniques**	**5 hours**

Review of DBMS Techniques – EER – Physical database design and tuning – Advanced transaction processing and Query processing

Module:2	**Parallel Databases**	**6 hours**

Architecture, Data partitioning strategy, Interquery and Intraquery Parallelism –Parallel query optimization

Module:3	**Distributed Databases**	**7 hours**

Structure of distributed database, Advantages, Functions, Distributed database architecture, Allocation, Fragmentation, Replication, Distributed query processing, Distributed transaction processing, Concurrency control and Recovery in distributed database systems.

Module:4	**Multimedia and Spatial Databases**	**7 hours**

Multimedia sources, issues, Multimedia database applications Multimedia database queries-LOB in SQL. Spatial databases -Type of spatial data– Indexing in spatial databases.

Module:5	**Mobile and Cloud Databases**	**8 hours**

Wireless network communication, Location and handoff management, Data processing and mobility, Transaction management in mobile database systems, Database options in the cloud, Changing role of the DBA in the cloud, Moving your databases to the cloud

Module:6	**Emerging Database Technologies**	**5 hours**

Active database – Detective database- Object database - Temporal database - Streaming databases

Module:7	**Database Security**	**5 hours**

Introduction to Database Security Issues –Security Models – Different Threats to databases – Counter measures to deal with these problems

Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Raghu Ramakrishnan, Database Management Systems, ,4th edition, Mcgraw-Hill,2015
2. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Seventh Edition, Tata McGraw Hill, 2019.

Reference Books

1. RamezElmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education, 2016.
2. Vlad Vlasceanu, Wendy A. Neu, Andy Oram, Sam Alapati, "An Introduction to Cloud

	Databases", O'Reilly Media, Inc. 2019			
3.	S.K.Singh, Database Systems: Concepts, Design & Applications, 2nd Edition, Pearson education, 2011			
Mode of Evaluation: CAT/ Digital Assignments/ Quiz/ FAT/ Project.				
Recommended by Board of Studies		11-02-2021		
Approved by Academic Council		No. 61	Date	18-02-2021

CSI2005	Principles of Compiler Design	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	Nil	**Syllabus version**				
		1.0				

Course Objectives:

1. To provide foundation for study of high performance compiler design.
2. To make students familiar with lexical analysis and semantic analysis.
3. To understand the principles of code optimization techniques.

Course Outcome:

1. Demonstrate the functioning of a Compiler and to develop a firm and enlightened grasp of concepts such as higher level programming, assemblers, automata theory, and formal languages, language specifications.
2. Develop language specifications using context free grammars (CFG).
3. Apply the ideas, the techniques, and the knowledge acquired for the purpose of developing software systems.
4. Construct symbol tables and generating intermediate code.
5. Obtain insights on compiler optimization

Student Learning Outcomes (SLO):	**1,2,5**

Module:1	**Introduction to Compilation and Lexcial Analysis**	**7 hours**

Introduction to programming language translators-Structure and phases of a compiler-Design issues- Patterns- lexemes-Tokens-Attributes-Specification of Tokens- Extended Regular expression, Regular expression to Deterministic Finite Automata (Direct method).

Module:2	**Syntax Analysis –Top Down**	**5 hours**

Role of parser- Parse Tree - Elimination of ambiguity - Top down parsing - Recursive Descent parsing - Non Recursive Descent parsing - Predictive Parsing - LL(1) grammars.

Module:3	**Syntax Analysis –Bottom Up**	**7 hours**

Shift Reduce Parsers- Operator Precedence Parsing ,LR parsers:-Construction of SLR parser tables and parsing , CLR parsing-LALR parsing

Module:4	**Semantics Analysis**	**6 hours**

Syntax Directed Definition – Evaluation Order - Applications of Syntax Directed Translation - Syntax Directed Translation Schemes - Implementation of L attributed Syntax Directed Definition.

Module:5	**Intermediate Code Generation**	**7 hours**

Variants of syntax trees - Three address code- Types – Declarations - Procedures - Assignment Statements - Translation of Expressions - Control Flow - Back Patching- Switch Case Statements.

Module:6	**Code Optimization**	**6 hours**

Loop optimizations- Principal sources of optimization -Introduction to Data Flow Analysis - Basic Blocks - The DAG Representation of Basic Blocks -Loops in Flow Graphs.

Module:7	**Code Generation & Other Translations Issues**	**5 hours**

Issues in the design of a code generator- Target Machine- Next-Use Information - Optimization of basic blocks - Peephole Optimization - Register Allocation and Assignment.

Module:8	Recent Trends	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. A. V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, Compilers: Principles, Techniques, & Tools, Second Edition, , Pearson Education, 2007
2. K. D. Cooper and L. Torczon, Engineering a Compiler, 2nd edition. Morgan Kaufmann, , 2011.

Reference Books				
1.	Andrew A.Appel , Modern Compiler Implementation in Java, 2nd edition, Cambridge University Press;, 2002.			
2.	Allen Holub, Compiler Design in C, Prentice Hall,1990.			
3.	Torbengidius Mogensen, "Basics of Compiler Design", Springer, 2011.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
Recommended by Board of Studies		11-02-2021		
Approved by Academic Council		No. 61	Date	18-02-2021

CSI2006	Microprocessor and Interfacing Techniques	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. To acquaint students with basic concepts of block diagram, architecture, pin diagram, addressing modes and instruction set of an 8086/ARM microprocessor.
2. To teach students syntax and semantics of assembly language programming and its constructs. To facilitate students to practice sample assembly programs and develop logic for other operations.
3. To explore special architectural features and various peripheral IC's for designing a typical computing system.
4. To understand the need for numeric co-processor. Also develop skill on open source prototyping boards for developing any smart systems for contemporary issues.

Course Outcome:

At the end of this course, students will be able to

1. Explain the design aspects of a typical microprocessor and illustrate its capabilities.
2. Practice and emulate assembly programs. To develop logic at assembly level for various operations.
3. Understand need for and working of Stack, Interrupt Service Routines (ISRs) and Procedures. Practice assembly programs for file handling and other operations using ISR.
4. Illustrate interfacing of basic devices viz. memory, IO, data converters and motors.
5. Illustrate interfacing of special purpose programmable devices viz. timer/counter, interrupt controller, display controller, communication and direct memory access.
6. Explain the design aspects of numeric co-processor and illustrate its capabilities with sample assembly programs.
7. Explore open source prototyping board, sample sensors and actuators and develop smart solutions for socio-economic issues.

Student Learning Outcomes (SLO):	2,5,9

Module:1	Intel x86/ARM Processors	5 hours

Architecture and Signal Description, Register and Memory Organization, General Bus Operations and IO Addressing Capability, Special Processor Activities, Min and Max Modes, Reduced-Instruction-Set Computing(RISC)

Module:2	Assembly Language Programming and Tools	5 hours

Addressing modes and Instruction Set, Assembler Directives and Operators, Introduction to emu8086 emulator and MASM assembler, Assembly Language example programs.

Module:3	Special Architectural Features and Programming	3 hours

Stack – stack structure of 8086/ARM and programming; Interrupt – interrupt cycle, non-mask-able, mask- able, Interrupt Service Routine, programming; procedure and macro– definition and passing parameters; handling larger programs; timing and delays – clock cycle, states, instruction execution time, clock count for generating delays; file management – create, open, close, read, write and delete operations;

Module:4	Basic Peripherals Interfacing	4 hours

Memory Interfacing – Interleaving, static and dynamic RAM interfacing; IO Ports Interfacing – memory mapped I/O, I/O mapped I/O; PIO 8255 – architecture, pin, control word register, operation modes; A/D Interfacing – 0808 SAR, 7109 dual-slope, interfacing; D/A – 7523, DAC0800; Stepper Motor – 4 winding internal schematic, excitation sequence, sample programs.

Module:5	Special Purpose Programmable Peripheral Interfacing	5 hours

Timer/Counter 8253 – architecture, pin, control word register, operation modes, programming; PIC-8259 – architecture, pin, interrupt sequence, command words, operation modes,

programming; 8279 – architecture, pin, operation modes, programming; 8251 – communication methods, architecture, pin, operation modes, programming; 8257 – architecture, pin, DMA transfers and operations, programming.		
Module:6	**Numeric Co-Processor 8087**	**4 hours**
Overview, compatible processor and coprocessor, pin, architecture, block diagram - control unit, numeric execution unit, registers, status word, circuit connection of 8086-8087,data types, IEEE floating point standard, instruction set, sample programs.		
Module:7	**Case Study on Microcontroller Boards**	**2 hours**
Introduction to Microcontroller, UNO Board, IDE, Programming using GPIO for LED, LCD, Keypad, Motor, Sensor interfacing, case study on smart system design.		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours	**30 hours**

Text Book(s)	
1.	A.K. Ray and K.M. Bhurchandi Advanced Microprocessors and Peripherals, 3rd Edition, Tata McGraw Hill, 2017.
2.	Barry B Bray , The Intel Microprocessor 8086/8088, 80186,80286, 80386 and 80486 Architecture, programming and interfacing, 8th Edition ,PHI, , 2011
Reference Book(s)	
1.	Douglas V. Hall, SSSP Rao" Microprocessors and Interfacing Programming and Hardware". Third edition, Tata McGraw Hill, 2017.
2.	Mohamed Rafiquazzaman, "Microprocessor and Microcomputer based system design," Second edition, Universal Book stall, 1995
3.	K Uday Kumar, B S Umashankar, Advanced Micro processors & IBM-PC Assembly Language Programming, Tata McGraw Hill, 2017.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Experiments		
1.	Arithmetic operations 8/16 bit using different addressing modes.	2 hours
2.	Finding the factorial of an 8 /16 bit number	1 hour
3.	(a) Solving nCr and nPr (b) Compute nCr and nPr using recursive procedure. Assume that 'n' and 'r' are non-negative integers.	2 hours
4.	Fibonacci series	1 hours
5.	Sorting in ascending and descending order	2 hours
6.	(a) Search a given number or a word in an array of given numbers. (b) Search a key element in a list of „n" 16-bit numbers using the Binary search algorithm.	2 hours
7.	To find the smallest and biggest numbers in a given array.	2 hours
8.	ALP for number bases conversions	2 hours
9.	String operations (String length, reverse, comparison, concatenation, palindrome)	2 hours
10.	Password checking	2 hours
11.	Convert a 16-bit binary value (assumed to be an unsigned integer) to BCD and display it from left to right and right to left for specified number of times	2 hours
12.	Read the current time from the system and display it in the standard format on the screen.	2 hours
13.	Program to simulate a Decimal Up-counter to display 00-99.	2 hours
14.	Read a pair of input co-ordinates in BCD and move the cursor to the specified location on the screen.	2 hours
15.	Stepper motor interface using 8086/ Intel Galileo Board	2 hours

16.	Seven segment LED DISPLAY using 8086/Intel Arduino Board			2 hours
			Total Laboratory Hours	**30 hours**
Mode of evaluation: CAT/FAT/Assignment				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18.02.2021	

CSI2007	Data Communication and Networks	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. Build an understanding of the fundamental concepts of computer networking, protocols, architectures, and applications
2. Gain expertise in design, implement and analyze performance perspective of TCP/IP layered Architecture
3. Deal with the major issues of the layers of the model.

Course Outcomes:

1. Describe the layered structure of a typical networked architecture
2. Identify and analyze the different types of network topologies, error and flow control mechanisms
3. Design sub-netting and enhance the performance of routing mechanisms.
4. Compare various congestion control mechanisms and identify suitable Transport layer protocol for real time applications
5. Identify various Application layer protocols for specific applications
6. Design and Implement various Network protocols

Student Learning Outcomes (SLO):	**2,5,6**

Module:1	Basics of Data Communication and Computer Network	5 hours

Definition and Uses of Computer Network, Criteria for a Data Communication Network, Components of Data Communication, Classification of Computer network, Network Topology, Network Models: OSI, TCP/IP- Networking Devices: Hubs, Bridges, Switches, Routers, and Gateways – Performance Metrics – Introduction to Sockets – Port numbers in Socket Programming

Module:2	Physical Layer	5 hours

Transmission Impairments, Transmission Medium,Data Encoding: Line Encoding, Types of Line Coding, Analog-to-Digital Conversion- Pulse code modulation (PCM), Delta modulation (DM);Transmission Modes- Half and Full Duplex- Signals – Bandwidth and Data Rate – Multiplexing – Shift Keying

Module:3	Data Link Layer	9 hours

Error Detection and Correction- One and two dimensional parity checks, Hamming code, Cyclic redundancy check (CRC); Flow Control: Protocols: Protocols for Noiseless Channels and Noisy Channels – Ethernet- Access Control Protocols: CSMA,CSMA/CA,CSMA/CD, Token Ring-Token Passing,TDMA,FDMA,CDMA-Virtual LAN- Wireless LAN (802.11).

Module:4	Network Layer	8 hours

IP Addressing Scheme, Subnet Addressing, Subnet Masks, IPV4 Addressing, IPV6 Addressing, Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP).Unicast Routing: Routing Characteristics, Routing Algorithms: Distance Vector Routing Protocol, Link State Routing Protocol – Multicast Routing- Wireless Routing

Module:5	Transport Layer	6 hours

Services of Transport Layer, Socket Programming, TCP Phases, Transport Layer Protocols: TCP, UDP, SCTP, RTP, Transport Layer Security Protocols : SSL,TLS

Module:6	Traffic Engineering Principles	4 hours

Congestion Control Algorithms- Congestion prevention policies; Quality of Service- Traffic shaping, Leaky bucket algorithm, Token bucket algorithm; Integrated Services.

Module:7	**Application Layer**	**6 hours**
Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP), TELNET,SNMP,DNS, Hypertext Transfer Protocol (HTTP), World Wide Web (WWW), Security in Internet, E-mail Security.		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	James Kurose , Keith Ross, Computer Networking: A Top-Down Approach, 7th edition Pearson, , 2016
2	Behrouz A. Forouzan, Data Communications and Networking, , 5th Ed. McGraw Hill Education,2012
Reference Books	
1	William Stallings, Data and Computer Communications, 10th Ed, Pearson Education, ,2013.
2	Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach, 5th Ed**,** Elsevier, 2011.
3	Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill, 2012.
4	Andrew S Tanenbaum, "Computer Networks", 5th Edition, Pearson, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Experiments		
1.	Basic Networking **Commands** using Linux	1 hour
2.	Error detection and correction mechanisms	4 hours
3.	Flow control mechanisms	4 hours
4.	IP addressing – Classless addressing	4 hours
5.	Routing Protocol Implementation and Performance Analysis of Routing protocols	4 hours
6	Socket Programming	4 hours
7	Transport Layer Security Protocol Implementation	4 hours
8	Congestion Control Protocol	3 hours
9	Study about Network Simulation tools	2 hours
Total Laboratory Hours		**30 hours**

Mode of evaluation: Assignment, CAT / Assignment / Quiz / FAT

Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI2008	Programming in Java	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. Understand Object Oriented Programming & Functional Programming in Java, Handling Exceptions and Multithreading.
2. Able to perform File Handling, Manipulating Strings, Generic Programming.
3. Use of Java for Event Handling and Web applications using Servlets.

Course Outcome:

At the end of this course students should be able to:

1. Analyze the programs involving the fundamental program constructs.
2. Choose the appropriate OOP technique for solving the real world problem.
3. Demonstrate exception handling and use of threads in Java.
4. Propose the use of Generic programming and file handling for different scenarios.
5. Explore various methods for manipulating strings and several collections.
6. Choose appropriate elements to facilitate event handling and GUI programming.
7. Design and develop web applications using Servlets with JDBC.

Student Learning Outcomes (SLO): **1, 9, 14**

Module:1	**Introduction to Java Programming**	**4 hours**

Overview of Java Language: Introduction, Java Virtual Machine, program structure, Java tokens, statements, variables, scope of variables and data types. Arrays: One-Dimensional arrays, Multidimensional Arrays.

Module:2	**Object, Class and Packages**	**7 hours**

Object Oriented Programming and Java –. Classes – Objects – Methods – Constructors – this keyword – Garbage collection – Overloading methods – Objects as parameters and returning objects – Nested and Inner classes – static and final keywords – Inheritance: Basics, Using super, Class hierarchy, Method overriding, Abstract classes – The Object Class – Packages and Interfaces.

Module:3	**Exceptions and Threads**	**7 hours**

Exception Handling: Fundamentals, Types, Uncaught Exceptions, Using try and catch, Multiple catch clauses, Nested try, Built-in Exceptions, Creating your own exception subclasses.
Threads: Java thread model, Main thread, Creating a thread, Creating multiple threads, Thread priorities, Synchronization, Inter thread communication, Thread's states, Multithreading.

Module:4	**Files and Generics**	**6 hours**

I/O streams – Console I/O – The PrintWriter class – Reading and Writing files. Generics: Basics, A Generic class, General form, Using wildcard arguments, Generic methods, Generic Interfaces, Generic Class hierarchy, Type inference.

Module:5	**Lambda Expressions and Strings**	**6 hours**

Lambda Expressions: Introduction, Block Lambda expressions, Passing Lambda expressions as arguments, Lambda Expressions and Exceptions.
String Handling: The String Constructors, Various String Operations, String Buffer and String Builder Classes.

Module:6	**Java Event Handling and GUI Programming**	**6 hours**

Event Handling mechanism, Event Delegation, Event and KeyEvent Classes, Event Listener Interfaces. GUI Programming with JavaFX: UI Controls, Layout Classes, Collection Classes, Media Classes.

Module:7	**Java Servlets and JDBC**	**7 hours**

Background - Lifecycle of a servlet – Development – The Servlet API – The javax.servlet package – Reading Servlet Parameters - Handling http requests and responses – Using Cookies –

Session Tracking – JDBC-Servlets with JDBC				
Module:8	**Recent Trends**			**2 hours**
	Total Lecture hours:			**45 hours**
Text Book(s)				
1.	Herbert Schildt, "Java: The Complete Reference", , 11th Edition., McGraw-Hill Publishers December 2018.			
2.	Cay S. Horstmann, "Core Java Volume I--Fundamentals", 11th Edition. , Pearson Publishers. August 2018.			
Reference Books				
1.	Ben Evans, David Flanagan, "Java in a Nutshell 7th Edition., O'Reilly Media, Inc. December 2018.			
2.	Joshua Bloch, "Effective Java".., 3rd Edition. Addison Wesley Publishers December 2018			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Experiments				
1.	Programs to demonstrate the use of arrays and various OOP concepts.			2 hours
2.	Programs to understand various exceptions and handling them.			2 hours
3.	Programs to demonstrate the concept of threads and multithreading in Java			2 hours
4.	Programs to understand Generic Programming technique and Lambda expressions.			4 hours
5.	Programs to create and manipulate file using different I/O methods.			4 hours
6.	Programs to explore various string handling methods.			3 hours
7.	Programs to idealize the use of different collection frameworks in java.util package and use of java.lang packages.			3 hours
8.	Programs to explore various swing elements to deepen the understanding of javaFX			3 hours
9.	Programs to realize the power of Java for internet programming through servlets.			3 hours
10.	Programs to realize the power of Java for internet programming through servlets with JDBC			4 hours
			Total Laboratory Hours	**30 hours**
Mode of evaluation: CAT / Assignment / Quiz / FAT				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18-02-2021	

CSI3001	Cloud Computing Methodologies	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Nil**	**Syllabus version 1.0**				

Course Objectives:

1. To introduce the concept of Virtualization and cloud computing
2. To provide students a sound foundation of the Cloud Computing enabling them to start using and adopting Cloud Computing services and tools in their real life scenarios
3. To enable students explore some important cloud computing driven commercial systems such as Google Apps, Microsoft Azure and Amazon Web Services and other businesses cloud applications.

Course Outcome:

1. Analyze and study the basics of cloud computing, cloud models and its applications
2. Appreciate the requirements of various service paradigms in Cloud Computing
3. Analyze, identify and select suitable type of virtualization
4. An ability to use techniques, tools, skills in a secured cloud environment
5. Design, implement and evaluate a cloud-based system, process, component, or program to meet desired needs

Student Learning Outcomes (SLO):	**5,9,17**	
Module:1	**Introduction**	**5 hours**
Overview of Computing Paradigm, Cloud Computing- NIST Cloud Computing Reference Architecture, Types of Cloud Deployment Models - Private, Public, Hybrid, Agency Clouds		
Module:2	**Cloud Service Models**	**5 hours**
Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), Anything as a Service(XaaS)		
Module:3	**Virtualization**	**7 hours**
Need for Virtualization – Pros and cons of Virtualization, Types - Implementation Levels – CPU, Memory, I/O Devices, Virtual Clusters and Resource management		
Module:4	**Cloud Environments**	**7 hours**
Cloud Environments - Case study: One cloud service provider per service model (eg. Amazon EC2, Google App Engine, Sales Force, Microsoft Azure, Open Source tools)		
Module:5	**Cloud Application Development**	**8 hours**
Cloud application development using third party APIs, Working with EC2 API – Google App Engine API - Facebook API, Twitter API , HDFS, Map Reduce Programming Model.		
Module:6	**Security**	**7 hours**
Cloud Security Challenges and Risks – Software-as-a- Service Security – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security		
Module:7	**Advances in Cloud**	**4 hours**
MQTT in Cloud, MQTT working example – Fog Computing basics – Comparing Cloud, Fog and Mist Computing		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Rajkumar Buyya, James Broberg, Andrzej, M. Goscinski, Cloud Computing: Principles and Paradigms, 1st Edition, Wiley,2013
2. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing: From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers,2013

Reference Books				
1. Sehgal, Naresh, Bhatt, Pramod Chandra P., Acken, John M, "Cloud Computing with Security Concepts and Practices", 2nd Edition , Springer International Publishing, 2020 2. Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi, "Mastering Cloud Computing" , 1st Edition, Tata McGraw Hill, 2017 3. Perry Lea, "IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security", 2nd Edition, Packt Publishing Limited, 2020				
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Indicative Experiments				
1.	Virtual box based Webserver creation, Images/Snapshots access web page from 2nd VM on another subnetwork			2 hours
2.	EC2 AWS – S3 bucket based static webpages.			2 hours
3.	EC2 AWS – Instance Creation, Migration			2 hours
4.	EC2 AWS – Web application using Beanstalk			2 hours
5.	AWS – Local balancing and auto scaling.			3 hours
6.	IBM Blue Mix - Mobile Application development			3 hours
7.	DaaS – Deployment of a basic web app and add additional functionality(Javascripts based)			3 hours
8.	PaaS – IOT – Mobile sensor based IOT application hosted via PaaS environment			3 hours
9.	SaaS – Deployment of any SaaS application for a online Collaborative tool			3 hours
10.	Deployment of Open stack or Virtual box from the scratch			3 hours
11.	Hadoop as a Service			2 hours
12.	Cloud TM Online Collaboration Services (User Defined Applications)			2 hours
			Total Laboratory Hours	**30 hours**
Mode of assessment: CAT1/CAT2/FAT				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18-02-2021	

CSI3002	Applied Cryptography and Network Security	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To learn the emerging concepts of cryptography and algorithms
2. To defend the security attacks on information systems using secure algorithms and Authentication process
3. To categorize and analyze the key concepts in network and wireless security

Course Outcome:

1. Infer the need of security to introduced strong cryptosystems.
2. Analyze the cryptographic algorithms for information security.
3. Identify the authentication schemes for membership authorization.
4. Identify computer and network security threats, classify the threats and develop a security model for detect and mitigate the attacks.
5. Identify the requirements for secure communication and challenges related to the secure web services
6. Identify the need of ethical and professional practices, risk management using emerging security solutions.

Student Learning Outcomes (SLO):	**1, 9, 18**	
Module:1	**Introduction to Cryptography**	**4 hours**
Security trends, Security attacks, Security mechanism, Elementary number theory, Pseudo-random bit generation. **Basic security services:** confidentiality, integrity, availability, non-repudiation, privacy.		
Module:2	**Symmetric Key Cryptography**	**4 hours**
Block Ciphers: DES, Triple-DES, AES, Modes of Operation, Stream Cipher		
Module:3	**Asymmetric Key Cryptography**	**4 hours**
RSA, Elgamal, Elliptic Curve Cryptography (ECC), Diffie-Hellman key exchange protocol		
Module:4	Hash Functions and Authentication	**4 hours**
Message Authentication Code (MAC), MD5, Secure Hash algorithms (SHA), HMAC, Digital Signatures, Digital Signature Standard (DSS).		
Module:5	**Basic Applied Cryptography**	**3 hours**
Key management and distribution, digital certificates, identity-based encryption, Identification and authentication, zero knowledge protocols		
Module:6	**Advanced Applied cryptography**	**5 hours**
Side-channel attack, Pretty Good Privacy (PGP), S/MIME, Kerberos, Homomorphic encryption, Quantum Cryptography, DNA Cryptography, Chaos Based Cryptosystem		
Module:7	**Web and Wireless Security**	**4 hours**
IPsec: AH and ESP, IKE- SSL/TLS, Types of Firewalls, Intrusion detection and Prevention systems, Wireless Application Protocol (WAP)		
Module:8	Recent Trends	**2 hours**
	Total Hours:	**30 hours**

List of Experiments

1	Implement DES, Triple DES and AES Key Algorithms	**4 Hours**
2	Implement RSA, ECC and Diffie-Hellman Key Establishment.	**4 Hours**
3	Implement a Secret-Sharing algorithm and Homomorphic Encryption algorithm	**2 Hours**
4	Implement message authentication (MAC) and HASH algorithms	**3 Hours**
5	Consider and examine the Wireless network security and technology	**2 Hours**

	integration for compliance using the case study of Cisco.	
6	Explore the Snort Intrusion Detection Systems. Study Snort IDS, a signature-based intrusion detection system used to detect network attacks. Snort can also be used as a simple packet logger. For the purpose of this lab the students will use snort as a packet sniffer and write their own IDS rules	**4 Hours**
7	Explore ways to perform wireless attacks and understand potential defences. The attacks that will be covered are inspecting & modifying wireless card parameters, changing the wireless transmission channel, flooding attacks, and cracking keys of WPA2 protected networks.	**4 Hours**
8	Pretty Good Privacy – • Create a public/private key pair in PGP • Create a revocation ley • Exchange PGP keys with other students • Signing the new key • Encrypting a file using your partner's public key • Decrypting the file using your private key • Encrypting and signing a file • Verifying the signature • Sending secure Email with PGP • Adding a public key and sending secure email.	**4 Hours**
9	Send and receive an encrypted email message using S/MIME.	**3 Hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	W. Stallings, Cryptography and Network Security: Principles and Practice, 7th Ed. Pearson Publishers, 2017.
2.	Behrouz A. Forouzan, Cryptography and Network Security:6th Ed. McGraw-Hill, 2017.

Reference Books	
1.	Kaufman, Perlman and Speciner. Network Security: Private Communication in a Public World., 2nd edition, Pearson Publishers, 2002.
2	Menezes, van Oorschot, and Vanstone, The Handbook of Applied Cryptography, 20th Edition, WILEY, 2015
3	H. Silverman, A Friendly Introduction to Number Theory, 4th Ed. Boston: Pearson, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18.02.2021

CSI3003	Artificial Intelligence and Expert Systems	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. Ability to understand Artificial Intelligence principles and techniques
2. Introduce the facts and concepts of Expert system by computational model and their applications
3. Explore the knowledge using problem solving, search methodologies and learning algorithms.

Course Outcome:

On completion of this course the students will be able to

1. Evaluate Artificial Intelligence (AI) methods and describe their foundations.
2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning.
3. Analyze and illustrate how search algorithms play vital role in problem solving
4. Demonstrate knowledge of reasoning and knowledge representation for solving real world problems
5. Understand and Illustrate the construction of expert system
6. Discuss current scope and limitations of AI and societal implications.

Student Learning Outcomes (SLO):	**1, 7, 17**	
Module:1	**Introduction to Artificial Intelligence**	**5 hours**
Overview of Artificial Intelligence –History of AI – Agents and environment – concept of rationality - Classification of AI systems with respect to environment.		
Module:2	**Problem solving**	**6 hours**
Solving problems by searching - Problem space - State space - searching for solutions - uninformed search strategies.		
Module:3	**Heuristic Search Strategies**	**6 hours**
Informed search strategies – Games: mini-max algorithm, Alpha-Beta Pruning		
Module:4	**Logical Agents**	**8 hours**
Knowledge-Based Agents - Wumpus World - Propositional Logic – Constraints, Predicate Logic – First Order Logic - Inference in First Order Logic		
Module:5	**Planning Agents**	**8 hours**
Situational Calculus - Representation of Planning - Partial order Planning- Practical Planners – Conditional Planning - Replanning Agents		
Module:6	**Knowledge Reasoning**	**5 hours**
Uncertainty - Bayes Rule – Inference-Hidden Markov Model- Belief Network, Decision Network		
Module:7	**Design of Expert System**	**5 hours**
Architecture of expert systems - Stages in the development of an Expert Systems - Roles of expert systems – Expert System Tools-Difficulties in Developing Expert Systems- Knowledge Acquisition and elicitation - Meta knowledge - Typical expert systems – MYCIN		
Module:8	**Recent Trends**	**2 hours**
	Total hours:	**45 hours**

Text Book(s)

1. Russell, S. and Norvig, P. Artificial Intelligence - A Modern Approach, 4th edition, Prentice Hall, 2020
2. Poole, D. and Mackworth, A. Artificial Intelligence: Foundations of Computational Agents, 2nd edition Cambridge University Press, 2017

Reference Books			
1.	Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007		
2.	Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007		
3	Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", 3rd Edition, McGraw Hill, 2008		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3023	Advanced Server Side Programming	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	NIL	Syllabus Version				
		1.0				

Course Objectives:

1. To understand different types of server-side programming and technologies like Servlets, JSP, ASP, EJB, JSF, PHP, Node.
2. Understand the various server-side Spring Frameworks, REST, SOAP, ORM, Security.

Course Outcome:

After successfully completing the course the student should be able to

1. Understand advanced server-side programming concepts and use technologies like Servlets, JSP, JSF and ASP
2. Adopt conveniently, ORM technique to bridge object and relational models of data.
3. Develop, real world API and Services using SOAP and REST.
4. Create application using Node.js and JMS API that provides the facility to create, send and read messages.
5. Efficiently create fast, secure, and responsive web applications using Spring Framework.

Student Learning Outcomes (SLO):	5,8,20	
Module:1	**Servlets, JSP, JSF and ASP**	**6 hours**

JSP, JSTL, Spring Tag Libraries, Spring Controllers , Template & Layout, Spring Form Validations(Standard and Custom),jQuery, CSS3, Web Descriptor Language, AJAX, Web Socker Support, Java server Faces, JSF flows, UI Model-Framework – JSP, JSTL, Tiles/Thymeleaf, Spring MVC on Spring Boot, Hibernate Validator

Module:2	**REST**	**3 hours**

Webservices, Types of Webservices, REST, JAX-RS, Rest Frameworks, Rest Methods and APIs, REST Clients.

Module:3	**SOAP**	**3 hours**

SOAP, JAX-WS, WSDL, SOAP Registries, SOAP Frameworks, SOAP Clients, Develop SOAP and REST API and Services. Framework – Spring MVC, Web-Services, Spring Security

Module:4	**ORM**	**5 hours**

Object Relation Mapping, JPA, Hibernate, Entity – Annotations, Association and In heritance mapping, Hibernate Session and Transaction, Caching, Native Query, HQL, Batch Processing and Intercepting Filter, Criteria Builder, Projections API, Named & Native Query. Framework – Spring Data JPA, Hibernate and JPA,MySQL/any rdbms Database

Module:5	**JMS, Node JS**	**4 hours**

JMS, Queues and Topics, Creating Queues and Topics, Sending and Receiving messages using Queues and Topics. Introduction to Node JS, Benefits and Features, NPM in Node JS, Event Handling. Framework – ActiveMQ or RabbitMQ, Spring JMS integration, NodeJS, NPM

Module:6	**Spring Framework**	**4 hours**

Developing a Batch Application that gets executed in the background process, and gets triggered at a specific regular intervals, Task/Tasklet, Steps, Sharing Batch Context Information between Steps

Module:7	**Exception Handling**	**3 hours**

Exception Handling, Transaction Commit Intervals, Chunk Processing, File/DB/JMS based Reader and Writers. Framework – Spring Boot, Spring Batch, Spring Data JPA, JMS and MySQL

Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Christian Bauer, Gavin King, Gary Gregory, Linda Demichiel, Java Persistence with

Hibernate, 2ed, MANNING Publications, 2016				
Reference Books(Links)				
1. David R. Heffelfinger , Java EE 8 Application Development, Packt Publishing, 2017. 2. Dhruti Shah , Node .js Guidebook, , First edition ,BPB Publications, 2018. 3. https://microservices.io/ 4. https://javaee.github.io/javaee-spec/ 5. https://spring.io/projects/ 6. https://nodejs.org/en/				
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Experiments				
1.	Develop a web application with AJAX and UI model framework			5 hours
2.	Create an application implementing a RESTful **API**			5 hours
3.	Create Web application using HTML, CSS and Node.js			5 hours
4.	Integrate Spring with ORM framework			5 hours
5.	Develop Web Applications using Spring Framework			5 hours
6	Create UI Management for Spring Boot and Node js applications			5 hours
			Total Laboratory Hours	**30 hours**
Mode of evaluation: CAT//Assignment/ FAT				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18.02.2021	

CSI3024	Software Application Architecture	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the architectures, frameworks, design patterns and its application architecture.
2. To understand the Core Java Design patterns, GOF, JEE Blue Print patterns and principles.
3. Monolithic, Need of Micro services Architecture, MS implementation, MS tools and technologies.
4. To understand what is an API, APIs classification and types, Technology specific APIs, API Tools.

Course Outcome:

Upon Completion of the course, the students able to

1. Design an application components using the appropriate design patterns (where, when, how and why).
2. Understand the difference between the Monolithic and Microservices architecture with patterns.
3. Design an applications using Microservices architecture based tools and technologies.
4. Analysis APIs for various types of services using different technologies

Student Learning Outcomes (SLO):	**2, 5,17**

Module:1	**Design Patterns**	**4 hours**

Architecture Styles and Patterns, Design Patterns and Principles, Frameworks, Architecture, Enterprise Architecture, Various Architecture Design pattern, Patterns History, MVC Design Patterns, Standards, Benefits.

Module:2	**Java Patterns**	**7 hours**

GOF and JEE Blue Print Patterns, Creational, Structural and Behavioural patterns, Modern Java EE Patterns, Core J2EE Patterns.

Module:3	**Architecture Types & Microservices Architecture**	**6 hours**

What are Microservices, Monolithic Vs Microservices, Microservices Challenges, Application Architecture Patterns, Service Decomposition, Building Microservices application,

Module:4	**Microservices Architecture Tools and Technologies**	**6 hours**

Deployment Patterns, Communication Style, Service Discovery, Externa API, Data Management, Security, Testing, Develop Spring Boot Microservices application.

Module:5	**Microservices Design Patterns**	**7 hours**

Managing transactions with SAGA, Distributed transactions, DDD aggregate pattern, Microservices Logging, Monitoring and Security, Microservices Cloud, Deploy Microservices with Docker, Adherence to QoS / NFR, Capacity Planning.

Module:6	**Introduction to API Tools and Technologies**	**7 hours**

API - API Design Principles, Types of APIs, Web APIs, REST APIs, SOAP APIs, Message APIs, RPCs, API Standards.

API Architecture, Building and using APIs, Exposing APIs, API Integration, API Documentation, API Clients, Securing APIs, Best Practices, API governance, API management and testing tools.

Module:7	**Batch and MQ Based Architecture**	**6 hours**

Web application & Batch Architecture, EAI Patterns and Implementations, Message based Integrations

Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 Hours**

Text Books	
1.	Freeman, E., Robson, E., Bates, B., & Sierra, K., Head first design patterns: A Brain-Friendly Guide - 10th Edition (Covers Java 8). " O'Reilly Media, Inc.", 2016.
2.	Fowler, M., Patterns of Enterprise Application Architecture, Addison-Wesley, 2012
Reference Books	
1.	Alur, D., Crupi, J., & Malks, D., Core J2EE patterns: best practices and design strategies. Prentice Hall Professional, 2003
2.	Richardson, C. Microservices patterns. Manning Publications Company,2018
3.	Nadareishvili, I., Mitra, R., McLarty, M., & Amundsen, M. , Microservice architecture: aligning principles, practices, and culture. " O'Reilly Media, Inc., 2016.
4.	Ajay Kumar,. Microservices architecture. Kindle Edition, 2018
5.	Piotr Mińkowski, Mastering Spring Cloud: Build self-healing, microservices-based, distributed systems using Spring Cloud. 1st edition, Packt Publishing, 2018
6.	Jin, B., Sahni, S., & Shevat, ADesigning Web APIs: Building APIs That Developers Love. " O'Reilly Media, Inc.", 2018)
7.	Medjaoui, M., Wilde, E., Mitra, R., & Amundsen, M, Continuous API Management: Making the right decisions in an evolving landscape. O'Reilly Media, 2018
8.	Masse, M.). REST API Design Rulebook: Designing Consistent RESTful Web Service Interfaces. " O'Reilly Media, Inc.",2011
9.	Hapner, M., Burridge, R., Sharma, R., & Fialli, J. Java Message Service API tutorial and reference: messaging for the J2EE platform. Addison-Wesley Professional.,2002.
10.	Web Links: • https://spring.io/projects/ • https://microservices.io/ • https://any-api.com/ • http://www.corej2eepatterns.com/
Mode of assessment: Continuous Assessment Test / Assignments / Quiz / FAT / Project / Seminar	

Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18.02.2021

CSI3025	Application Development and Deployment Architecture	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand various process & methodologies to be followed during development life cycle
2. To design the deployment architecture and preparing for the release management plan.
3. To use the various tools and framework associated with development and deployment of the applications.

Course Outcome:

On completion of the course, the students able to:

1. Understand the complexities in setting up an Enterprise grade development and deployment of architecture.
2. Analyse and make a plan for release management
3. Design and rollout Deployment Architecture
4. Analyze various tools and framework associated with development and deployment.

Student Learning Outcomes (SLO):	**2, 4, 17**

Module:1	**Development Life Cycle and Processes**	**4 hours**

Waterfall, Agile & Scrum Methodologies, Iterative Development, Development Productivity Tools such as Accelerators, Reusable Components, Centralized Library Repository, Application Debugging (local and remote), Project Setup & Configuration, Introduction to Function Point Estimate, Introduction to Size and Complexity Estimation.

Module:2	**Build, Source Control and Release Management**	**3 hours**

Build Management: Build Life Cycle, Build Goals, Build Profile, Build Plugins, Build Test, Release Management: managing, planning, scheduling and controlling a software build through different stages and environments; including testing and deploying software releases.

Module:3	**Code Baseline**	**4 hours**

Code Baseline, Tagging Process, Release/Master/Feature Branch, Pull Request, Local Repo, Resolve Conflicts, Merge contributions from many source, Version history management, integrating with issue tracker

Module:4	**Deployment Architecture**	**4 hours**

Network Topology – VLAN, DMZ's, Private and Public Subnets, Security Group, NAT Gateways, Host-Names, Capacity Planning and Sizing (application and data), Security Architecture (Data on transit, Data on storage, User & Application Security, Federation) , Cloud Architecture, DR & BCP Planning, Infra & Service Monitoring (Network, Apps, Data, Logs) , Centralized Log Management (ELK).

Module:5	**Containers and Virtualization**	**4 hours**

Docker CE, Kubernetes, API and SDK, Failover, Scalability, Distributed Data, Detection and Self-Healing, Release Management (Planning, Re-Routing, Installation, Pre-Validation, Rollback Strategy)

Module:6	**DevOps**	**5 hours**

Intro to DevOps, LifeCycle, Continuous Integration , Delivery and Deployment, Pipelines, Integration with Unit Tests, Integration Tests, Performance or Load Test & Security Test Cases, Reporting, , Integration with Containers and Kubernetes or equivalent.,

Module:7	**Security Management**	**4 hours**

WORM, Data Cloning, HSM, Centralized Log Management, Password Management, Release Management (Planning, Re-Routing, Installation, Pre-Validation, Rollback Strategy)

Module:8	**Recent Trends**	**2 hours**

			Total Lecture hours	**30 hours**
Text Books				
1.	Davis, J., & Daniels, R., Effective DevOps: building a culture of collaboration, affinity, and tooling at scale. " O'Reilly Media, Inc.", 2016			
2.	Howard, D. IT release management: A hands-on guide. CRC Press, 2010			
Reference Books				
1	Ryan Lister, Docker: The Complete Beginner's Guide Paperback. Createspace Independent Pub., 2017			
3	Joseph D. Moore, Kubernetes: The Complete Guide to Master Kubernetes. Kindle Edition, 2019.			
4	Richard Bullington-McGuire, Andrew K. Dennis, Michael Schwartz., Docker for Developers: Develop and run your application with Docker containers using DevOps tools for continuous delivery, Packt Publishing, 2020			
	Web Links: • https://try.github.io/ • https://www.bugzilla.org/docs/2.16/html/how.html • https://maven.apache.org/guides/getting-started/maven-in-five-minutes.html			
Mode of Evaluation: CAT / Assignment / Quiz /FAT / Project / Seminar				
List of Experiments				
1	Technical Stack/Framework- Java 8+, Jenkins and it usage in real world applications with a scenario.			4 hours
2	Technical Stack/Framework-SonarQube and it usage in real world applications with a scenario.			4 hours
3	Technical Stack/Framework-Maven, JUnit5 and it usage in real world applications with a scenario.			4 hours
4	Technical Stack/Framework- Selenium, Git Client, Git Server and it usage in real world applications with a scenario.			6 hours
5	Technical Stack/Framework- Bugzilla, Eclipse STS and it usage in real world applications with a scenario.			4 hours
6	Technical Stack/Framework- Docker and it usage in real world applications with a scenario.			4 hours
7	Technical Stack/Framework- Kubernetes, CGroup and it usage in real world applications with a scenario.			4 hours
			Total Laboratory Hours	**30 hours**
Mode of assessment: CAT / FAT				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18.02.2021	

CSI3026	Machine Learning	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		1.0				

Course Objectives:

1. Understand the basics and mathematical concepts of machine learning algorithms.
2. Choose and apply appropriate machine learning models for real world application.
3. Assess the performance of algorithms and to provide solution for various real-world problems.

Course Outcome:

1. Understand the characteristics of machine learning strategies.
2. Apply suitable supervised learning methods to suitable problems.
3. Enhance the performance of learning by identifying and integrating more than one machine learning technique.
4. Handle unknown pattern by creating suitable probabilistic and unsupervised learning models.
5. Choose appropriate preprocessing methods to data before applying to real-world applications and to evaluate the performance and analyse the results.

Student Learning Outcomes (SLO):	7, 9, 17

Module:1	Introduction To Machine Learning	3 hours

Introduction, Examples of Various Learning Paradigms, Perspectives and Issues, Version Spaces, Finite and Infinite Hypothesis Spaces, PAC Learning, VC Dimension.

Module:2	Supervised Learning	9 hours

Learning a Class from Examples, Linear, Non-linear, Multi-class and Multi-label classification, Decision Trees: ID3, Classification and Regression Trees (CART), Regression: Linear Regression, Multiple Linear Regression, Logistic Regression.

Module:3	Neural Networks and Support Vector Machines	3 hours

Neural Networks: Introduction, Perceptron, Multilayer Perceptron, Back-propagation, Support vector machines: Linear and Non-Linear, Kernel Functions, K-Nearest Neighbors

Module:4	Ensemble Learning Methods	5 hours

Ensemble Learning Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking

Module:5	Unsupervised Learning Methods	3 hours

Introduction to clustering, Hierarchical: AGNES, DIANA, Partitional: K-means clustering, K-Mode Clustering, Principal Component Analysis (PCA), Locally Linear Embedding (LLE), Factor Analysis

Module:6	Statistical Learning Methods	3 hours

Naïve Bayes Classifier, Bayesian Belief Networks. Reinforcement Learning - Introduction, types of reinforcement learning algorithms, application and challenges in reinforcement learning

Module:7	Performance Evaluation	2 hours

Design, Analysis and Evaluation of Machine Learning Algorithms with various datasets, Other Issues: Handling imbalanced data sets, missing data and outliers.

Module:8	Recent Trends	2 hours
	Total Lecture hours:	30 hours

Text Book(s)

1. Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Third Edition, 2014.
2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2012.

Reference Books

1. Tom Mitchell, "Machine Learning", 3rd Edition, McGraw Hill, 1997.

2.	Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012			
3.	Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2019.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Experiments				
1.	Implement Decision Tree learning			2 hours
2.	Implement Logistic Regression			2 hours
3.	Implement classification using Multilayer perceptron			2 hours
4.	Implement classification using SVM			2 hours
5.	Implement Adaboost			2 hours
6.	Implement Bagging using Random Forests			3 hours
7.	Implement k-nearest Neighbours algorithm			2 hours
8.	Implement K-means, K-Modes Clustering to Find Natural Patterns in Data			3 hours
9.	Implement Hierarchical clustering			3 hours
10.	Implement Gaussian Mixture Model Using the Expectation Maximization			3 hours
11.	Implement Principle Component Analysis for Dimensionality Reduction			3 hours
12.	Evaluating ML algorithm with balanced and unbalanced datasets Comparison of Machine Learning algorithms			3 hours
Total Laboratory Hours				**30 hours**
Mode of assessment:				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18.02.2021	

CSI3029	Front End Design and Testing	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. To understand JavaScript based MVC Framework, UI Componentization and steps to develop a scalable UI application.
2. To acquire knowledge on Reactive Programming, Responsive web Design, Multi Device Compatible applications (RWD), Native Mobile Apps.

Course Outcome:

1. Apply HTML, CSS to create and design websites.
2. Apply JavaScript effectively to create interactive and dynamic websites.
3. Design and Develop Scalable Web Apps using SPA framework - AngularJS
4. Develop routing and servicing applications.
5. Apply supporting functions for logging, exception handling and performance engineering.
6. Implement Responsive web design using Bootstrap and multi device compatible App with native mobile support.
7. Design and perform unit testing.

Student Learning Outcomes (SLO):	5, 7, 9

Module:1	HTML and CSS	5 hours

HTML5 – Form elements, Input types and Media elements, CSS3 - Selectors, Box Model, Backgrounds and Borders, Text Effects, Animations, Multiple Column Layout, User Interface

Module:2	JavaScript	3 hours

JavaScript Introduction –Functions – Arrays – DOM, Built-in Objects, Regular Expression, Event handling.

Module:3	Introduction to SPA	4 hours

Introduction to Single Page Application (SPA)& Angular Architecture, TypeScript Language and its Feature, SPA's Components and Templates, Forms (Template/Reactive), Promise and Observable, CLI Features

Module:4	Service and Routes	3 hours

Service Definition and Injection, Routes and Navigation, Data Integrity enablement, State Management, Security (Authentication & Authorization, Auth-Guards), Pipes & Directives, Promise and Observable, Subject & Behaviour Subject, Intra Component Communication, ngrx, rxjs, of keyword.

Module:5	Supporting Functions	4 hours

I18n & i10N, Logging and Exceptions handling, Interceptors, Performance Engineering, Unit Testing using Jasmine and Karma, DevOps Enablement.

Module:6	Responsive web Design, Mobile Apps	3 hours

Responsive Web design using Bootstrap and MD, Native Mobile apps using Ionic/Cardova/Native Script, Desktop Applications

Module:7	Unit Testing	6 hours

Unit Testing using Jasmine and Karma, Development of Re-usable web components ,Deployment, Mono Repo

Module:8	Recent Trends	2 hours
	Total Lecture hours:	30 hours

Text Book(s)

1	Fritz Schneider, Thomas Powell, JavaScript – The Complete Reference, 3rd Edition, McGraw Hill, 2017.
2	'Mastering TypeScript 3: Build enterprise-ready, industrial-strength web applications using

	TypeScript 3 and modern frameworks, 3rd Edition', by Nathan Rozentals, Birmingham : Packt Publishing Ltd, 2019.			
Reference Books				
1	Responsive Web Design with HTML5 and CSS: Develop future-proof responsive websites using the latest HTML5 and CSS techniques by Ben Frain, 3rd Edition, Packt Publishing, April, 2020.			
2	'Hands-On Functional Programming with TypeScript: Explore functional and reactive programming to create robust and testable TypeScript applications', by Remo H. Janse, Packt Publishing, January 2019.			
3	"Angular 2 Cookbook", by Matt Frisbie, Packt Publishing Limited, January 2017.			
	https://angular.io/ https://api.jquery.com/ https://material.io/design/ https://getbootstrap.com/			
Mode of Evaluation: CAT / Assignment / Quiz / FAT				
Lab Experiments				
The problem statement chosen for this lab exercises is FEE Framework.				
1	Develop the website with at least 5 pages using HTML and CSS.			2 hours
2	Develop JavaScript code to perform client side validation.			2 hours
3	Programs on AngularJS components			3 hours
4	Implementation of simple business logic using CLI of AngularJS.			4 hours
5	Program for AngularJS routing			4 hours
6	Program to perform unit test using AngularJS.			4 hours
7	Create a responsive web Design using Bootstrap.			3 hours
8	Develop native mobile application using iconic framework			4 hours
9	Perform unit testing using Jasmine and Karma			4 hours
			Total hours	**30 hours**
Mode of Assessment:				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18.02.2021	

EEE1024	Fundamentals of Electrical and Electronics Engineering	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1] To teach the simple problem of DC and AC circuits.
2] To study the important concepts of Analog and digital electronics.
3] To measure and interpret data

Expected Course Outcome:

On the completion of this course the student will be able to:
1] Solve simple DC circuits using mesh and nodal analysis.
2] Describe the RLC components with sinusoidal sources.
3] Design of combinational circuits and synthesis of logic circuits
4] Utilize the basic concepts of semiconductor devices and circuits
5] Interpret the architecture of microprocessor & microcontrollers
6] measure the various signals using the sensors
7] Discuss the overview of communication systems.
8] Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Fundamentals of DC circuits:**	**5 hours**

Basic circuit elements and sources, Ohms law, Kirchhoff's laws, Node voltage analysis, Mesh current analysis, Thevenin's and Maximum power transfer theorem.

Module:2	**Fundamentals of AC Circuits:**	**4 hours**

Introduction to AC circuits, Steady state AC analysis of a RL, RC, RLC Series circuits, AC power calculations.

Module:3	**Digital Systems:**	**4 hours**

Number system, Boolean algebra, Logic circuit concepts, Multiplexer, Demultiplexer, Half adder, Full adder, Computer organization, Memory types, Flip Flops, Counters.

Module:4	**Semiconductor devices:**	**3 hours**

Conduction in semiconductor materials, principle of operation, V-I characteristics of PN junction diode, Zener diode, BJT, half wave rectifier, full wave rectifier.

Module:5	**Microprocessor & microcontroller:**	**4 hours**

Overview of ARM architecture, Different modes of ARM processor, various instructions, 8051 Microcontroller architecture, Applications.

Module:6	**Measuring Instruments and Sensors:**	**5 hours**

Measuring Instruments: Classification of instruments, Working principle of PMMC, MI, Digital & Smart Meters, Ammeter, Voltmeter & wattmeter.
Sensors: Transducers classification & selections, Resistive, Inductive and capacitive sensors, Optical and Digital sensors

Module:7	**Communication systems**	**3 hours**

Modulation and Demodulation – Amplitude, frequency, digital modulation, wired and wireless communication – concept and types

Module:8	**Lecture by industry experts.**	**2 hours**
	Total Lecture hours:	**30 hours**

List of Challenging Experiments (Indicative)		
Software Experiments		
1.	Analysis and verification of circuit using Mesh and Nodal analysis	2 hours
2.	Verification of network theorems using Maximum power	2 hours

	transfer	
3.	Analysis of Single AC circuit with R, RL and RC loads	2 hours
4	Design of half adder and full adder	2 hours
5.	Single phase half wave	2 hours
6.	Full wave rectifier	2 hours
7.	Design of controlled switch using BJT	2 hours
Hardware Experiments		
1.	Verification of network theorems using Thevenin's	2 hours
2.	Regulated power supply using Zener diode	2 hours
3.	Design of a lamp dimmer circuit using Darlington pair	2 hours
4	Design and verification of logic circuit by simplifying the Boolean expression	2 hours
5.	Calibration of voltmeter and Ammeter	2 hours
6.	Wiring connection for Fan	2 hours
7.	Staircase wiring layout for multi-storied building	2 hours
8.	Study on Microprocessor kit	2 hours
	Total Laboratory Hours	**30 hours**
Text Book(s)		
1.	Allan R. Hambley, 'Electrical Engineering - Principles & Applications, Pearson Education, First Impression, 6/e, 2013.	
2.	John Bird, 'Electrical circuit theory and technology', Newnes publications, 4th Edition, 2010.	
3.	Mohammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems ", Pearson education, 2nd Edition, 2014.	
4	D.V.S.Murthy, "Transducers and Instrumentation", Prentice Hall of India Learning Pvt. Ltd. 2nd edition 2012.	
5	Simon Haykin; Michael Moher, "An Introduction to Analog and Digital Communications.", Hoboken : Wiley Textbooks, 2nd Edition, 2012.	
Reference Books		
1.	Charles K Alexander, Mathew N O Sadiku, 'Fundamentals of Electric Circuits', Tata McGraw Hill, 2012.	
2.	David A. Bell, 'Electronic Devices and Circuit', Oxford press-2008.	
3.	M. Morris Mano, Charles R. Kime, 'Digital Design and Computer Organization', Pearson Education, December 1994.	
4.	D. Roy Choudhary, Shail B. Jain, 'Linear Integrated Circuits', 4th/e, New Age International, 2010.	
5.	A.K. Sawhney, "A Course In Electrical And Electronic Measurements And Instrumentation", Dhanpat Rai Publications, 2012.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
Recommended by Board of Studies	16-09-2020	
Approved by Academic Council	No. 59	Date 24-09-2020

MAT1014	Course title	L	T	P	J	C
	Discrete Mathematics and Graph Theory	3	2	0	0	4
Pre-requisite	**None**	**Syllabus Version**				
		1.1				

Course Objectives (CoB): 1,2,3

- To address the challenge of the relevance of lattice theory, coding theory and algebraic structures to computer science and engineering problems.
- To use number theory, in particular congruence theory to cryptography and computer science problems.
- To understand the concepts of graph theory and related algorithm concepts.

Expected Course Outcome (CO): 1,2,3,4,5

At the end of this course, students are expected to

1. form truth tables, proving results by truth tables, finding normal forms,
2. learn proof techniques and concepts of inference theory
3. understand the concepts of groups and application of group codes, use Boolean algebra for minimizing Boolean expressions.
4. learn basic concepts of graph theory, shortest path algorithms, concepts of trees and minimum spanning tree and graph colouring, chromatic number of a graph.
5. Solve Science and Engineering problems using Graph theory.

Student Learning Outcomes (SLO): 1, 2, 7

Module:1	**Mathematical Logic and Statement Calculus**	**6 hours**

Introduction-Statements and Notation-Connectives–Tautologies–Two State Devices and Statement logic -Equivalence - Implications–Normal forms - The Theory of Inference for the Statement Calculus.

Module:2	**Predicate Calculus**	**4 hours**

The Predicate Calculus - Inference Theory of the Predicate Calculus.

Module:3	**Algebraic Structures**	**5 hours**

Semigroups and Monoids - Groups – Subgroups – Lagrange's Theorem Homomorphism – Properties-Group Codes.

Module:4	**Lattices**	**5 hours**

Partially Ordered Relations -Lattices as Posets – Hasse Digram – Properties of Lattices.

Module:5	**Boolean algebra**	**5 hours**

Boolean algebra - Boolean Functions-Representation and Minimization of Boolean

Functions –Karnaugh map – McCluskey algorithm.		
Module:6	**Fundamentals of Graphs**	**6 hours**
Basic Concepts of Graph Theory – Planar and Complete graph - Matrix representation of Graphs – Graph Isomorphism – Connectivity–Cut sets-Euler and Hamilton Paths–Shortest Path algorithms.		
Module:7	**Trees, Fundamental circuits , Cut sets, Graph colouring, covering, Partitioning**	**12 hours**
Trees – properties of trees – distance and centres in tree –Spanning trees – Spanning tree algorithms- Tree traversals- Fundamental circuits and cut-sets. Bipartite graphs - Chromatic number – Chromatic partitioning – Chromatic polynomial - matching – Covering– Four Colour problem.		
Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**
Tutorial	• A minimum of 10 problems to be worked out by students in every Tutorial class. • Another 5 problems per Tutorial Class to be given as home work. **Mode:** Individual Exercises, Team Exercises, Online Quizzes, Online, Discussion Forums	**30 hours**

Text Book(s)

1. Discrete Mathematical Structures with Applications to Computer Science, J .P. Trembley and R. Manohar, Tata McGraw Hill-35th reprint, 2017.
2. Graph theory with application to Engineering and Computer Science, Narasing Deo, Prentice Hall India 2016.

Reference Books

1. Discrete Mathematics and its applications, Kenneth H. Rosen, 8th Edition, Tata McGraw Hill, 2019.
2. Discrete Mathematical Structures, Kolman, R.C.Busby and S.C.Ross, 6th Edition, PHI, 2018.
3. Discrete Mathematics, Richard Johnsonbaugh, 8th Edition, Prentice Hall, 2017.
4. Discrete Mathematics, S. Lipschutz and M. Lipson, McGraw Hill Education (India) 2017.
5. Elements of Discrete Mathematics–A Computer Oriented Approach, C.L.Liu, Tata McGraw Hill, Special Indian Edition, 2017.
6.Introduction to Graph Theory, D. B. West, 3rd Edition, Prentice-Hall, Englewood Cliffs, NJ, 2015.

Mode of Evaluation

Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test

Recommended by Board of Studies	

Approved by Academic Council	No. 47	Date	05-10-2017

MAT1022	Linear Algebra	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**MAT1011**	**Syllabus Version**				
		1.0				

Course Objectives :

[1] Understanding basic concepts of linear algebra to illustrate its power and utility through applications to computer science and Engineering.
[2] apply the concepts of vector spaces, linear transformations, matrices and inner product spaces in engineering.
[3] solve problems in cryptography, computer graphics and wavelet transforms

Course Outcome :

At the end of this course the students are expected to learn
[1] The abstract concepts of matrices and system of linear equations using decomposition methods
[2] The basic notion of vector spaces and subspaces
[3] Apply the concept of vector spaces using linear transforms which is used in computer graphics and inner product spaces
[4] Applications in image processing.
[5] Applications of inner product spaces in cryptography

Module:1	**System of Linear Equations**:	**6 hours**

Rank of matrix -Gaussian elimination and Gauss Jordan methods - Elementary matrices- permutation matrix - inverse matrices - System of linear equations - LU factorizations.

Module:2	**Vector Spaces**	**6 hours**

The Euclidean space R^n and vector space- subspace –linear combination-span-linearly dependent-independent- bases - dimensions-finite dimensional vector space.

Module:3	**Subspace Properties**:	**6 hours**

Row and column spaces -Rank and nullity – Bases for subspace – invertibility- Application in interpolation.

Module:4	**Linear Transformations and applications**	**7 hours**

Linear transformations – Basic properties-invertible linear transformation - matrices of linear transformations - vector space of linear transformations.

Module:5	**Inner Product Spaces:**	**6 hours**

Dot products and inner products – the lengths and angles of vectors – matrix representations of inner products- Gram-Schmidt orthogonalisation

Module:6	**Applications of Inner Product Spaces**:	**6 hours**

QR factorization- Projection - orthogonal projections -Least Square solutions in Computer Codes.

Module:7	**Applications of Linear equations** :	**6 hours**

An Introduction to coding - Classical Cryptosystems –Plain Text, Cipher Text, Encryption, Decryption .

Module:8	**Contemporary Issues:**	**2 hours**

Industry Expert Lecture and R & D.

	Total Lecture hours:	**45 hours**	

Text Book(s)			
1. Linear Algebra, Jin Ho Kwak and Sungpyo Hong, Second edition Springer(2004). (Topics in the Chapters 1,3,4 &5) 2. Introductory Linear Algebra- An applied first course, Bernard Kolman and David, R. Hill, 9th Edition Pearson Education, 2011.			
Reference Books			
1. Elementary Linear Algebra, Stephen Andrilli and David Hecker, 5th Edition, Academic Press(2016) 2. Applied Abstract Algebra, Rudolf Lidl, Guter Pilz, 2nd Edition, Springer 2004. 3. Contemporary linear algebra, Howard Anton, Robert C Busby, Wiley 2003 4. Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Cengage Learning (2015).			
Mode of Evaluation			
Digital Assignments,Continuous Assessments, Final Assessment Test			
Recommended by Board of Studies	30.06.2021		
Approved by Academic Council	63	Date	23.09.2021

CSI3005	Advanced Data Visualization Techniques	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. To understand the various types of data, apply and evaluate the principles of data visualization
2. Acquire skills to apply visualization techniques to a problem and its associated dataset
3. To apply structured approach to create effective visualizations
4. To learn how to bring valuable insight from the massive dataset using visualization
5. To learn how to build visualization dashboard to support decision making
6.To create interactive visualization for better insight using various visualization tools

Course Outcome:

After successfully completing the course the student should be able to

1. Identify the different data types, visualization types to bring out the insight.
2. Relate the visualization towards the problem based on the dataset to analyze and bring out valuable insight on large dataset.
3. Design visualization dashboard to support the decision making on large scale data.
4. Demonstrate the analysis of large dataset using various visualization techniques and tools.

Student Learning Outcomes (SLO):	4, 7, 12

Module:1	**Introduction to Data Visualization and Visualization techniques**	**6 hours**

Overview of data visualization - Data Abstraction - Task Abstraction - Analysis: Four Levels for Validation. Visualization Techniques -Scalar and point techniques – colour maps – Contouring – Height Plots - Vector visualization techniques – Vector properties – Vector Glyphs – Vector Color Coding

Module:2	**Visual Analytics**	**5 hours**

Visual Variables- Networks and Trees –Tables - Map Color and Other Channels- Manipulate View

Module:3	**Visualization Tools**	**6 hours**

Fundamentals of R- Visualization using R library -Introduction to various data visualization tools- tableau

Module:4	**Geo spatial visualization**	**6 hours**

Geo spatial data and visualization techniques : Chloropleth map, Hexagonal Binning, Dot map, Cluster map, cartogram map

Module:5	**Diverse Types Of Visual Analysis**	**6 hours**

Time- Series data visualization – Text data visualization – Matrix visualization techniques - Heat Map- Multivariate data visualization and case studies

Module:6	**Visualization of Streaming Data**	**7 hours**

Introduction to Data Streaming, processing and presenting of streaming data, streaming visualization techniques, streaming analysis.

Module:7	**Visualization Dashboard Creations**	**7 hours**

Dashboard creation using visualization tools for the use cases: Finance-marketing-insurance-healthcare etc.,

Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours	**45 hours**

Text Books

1. Tamara Munzer, Visualization Analysis and Design, CRC Press 2014.
2. Aragues, Anthony. Visualizing Streaming Data: Interactive Analysis Beyond Static Limits. O'Reilly Media, Inc., 2018

Reference Books

1. Chun-hauh Chen, W.K.Hardle, A.Unwin, Hand book of Data Visualization, Springer publication, 2016.
2. Christian Toninski, Heidrun Schumann, Interactive Visual Data Analysis, CRC press publication,2020
3. Alexandru C. Telea, Data Visualization: Principles and Practice, AK Peters, 2014.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Seminar

List of Experiments:

1	Acquiring and plotting data.	2 hours
2	Statistical Analysis – such as Multivariate Analysis, PCA, LDA, Correlation regression and analysis of variance	4 hours
3	Financial analysis using Clustering, Histogram and HeatMap	4 hours
4	Time-series analysis – stock market	4 hours
5	Visualization of various massive dataset - Finance – Healthcare - Census - Geospatial	4 hours
6	Visualization on Streaming dataset (Stock market dataset, weather forecasting)	4 hours
7	Market-Basket Data analysis-visualization	4 hours
8	Text visualization using web analytics	4 hours
	Total Lecture hours	**30 hours**

Mode of evaluation: Project/Activity

Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3006	Soft Computing Techniques	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for real-world problems.
2. To provide adequate knowledge of non-traditional technologies and fundamentals of artificial neural networks, backpropagation networks, fuzzy sets, fuzzy logic, genetic algorithms in solving social and engineering problems.
3. To provide comprehensive knowledge of swarm intelligence and rough set concepts

Course Outcome:

The student will be able

1. Apply neural networks, advanced AI techniques of swarm intelligence and rough set concepts for solving different engineering problems
2. Identify and describe soft computing techniques and build supervised learning and unsupervised learning networks.
3. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
4. Apply genetic algorithms to combinatorial optimization problems.
5. Evaluate and compare solutions by various soft computing approaches for a given problem.
6. Use existing software tools to solve real problems using a soft computing approach

Student Learning Outcomes (SLO):	**1, 7, 14**	
Module:1	**Introduction to Soft Computing**	**3 hours**

Overview of Soft Computing, Soft Vs Hard computing, Components of soft computing, Introduction to neural networks, Fuzzy logic, Genetic algorithms. Artificial neural networks Vs Biological neural networks, Neural network architectures, Characteristics of neural network, Early neural network architectures (MADALINE network), and Application domains.

Module:2	**Back Propagation networks**	**8 hours**

Architecture of a back propagation network, Backprogragation learning, Effect of tuning parameters, Selection of parameters in back propagation network, Application domains.

Module:3	**Associative Memory Networks**	**7 hours**

Autocorrelators, heterocorrelators: Kosko's discrete Bi-direction Associative Memory (BAM), Exponential BAM, Associative memory for real-coded pattern pairs, Application - Character Recognition.

Module:4	**Unsupervised learning networks**	**7 hours**

Neural Nets based on competition, Max net, Mexican Hat, Hamming net, Kohonen Self organizing Feature Map, Counter propagation, Learning Vector Quantization , Adaptive Resonance Theory

Module:5	**Advanced AI Techniques and Rough set concepts**	**6 hours**

Swarm Intelligence (SI), Particle swarm optimization (PSO), Ant Colony Optimization, Petrinets, Coloured Petrinets, Entropy, Rough sets, Rough set theory, Set approximation, Rough membership, Attributes, Dependency of attributes, Rough equivalence, Reducts, Rough Reducts based on SVM

Module:6	**Fuzzy Logic and Inference**	**6 hours**

Fuzzy Logic, Predicate Logic, Fuzzy Quantifiers, Fuzzy Inference , Fuzzy knowledge and rule based system, Fuzzy decision making, Defuzzification, Applications of fuzzy logic, Neuro Fuzzy modelling

Module:7	**Genetic Algorithms**	**6 hours**

Basic concepts, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional method		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. D. K. Pratihar, Soft Computing : Fundamentals and Applications,2nd Ed., Narosa, 2013
2. S.N. Sivanandam& S.N. Deepa, "Principles of Soft Computing", 3rd ed, Wiley Publications,2018.

Reference Books

1. Jang, Jyh-Shing Roger, Chuen-Tsai Sun, and EijiMizutani. "Neuro-fuzzy and soft computing-a computational approach to learning and machine intelligence" Pearson, 1997.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 3rd ed, John Wiley and Sons, 2011.
3. S, Rajasekaran & G.A. VijayalakshmiPai, "Neural Networks, Fuzzy systems and evolutionary algorithms: Synthesis and Applications", 2nd Ed , PHI Publication,. 2017.
4. George J. Klir,Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 2015

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3007	Advanced Python Programming	L	T	P	J	C
		2	0	4	0	4
Pre-requisite	CSE1001	**Syllabus version**				
		1.0				

Course Objectives:

1. To be able to apply advanced python programming concepts for industry standard problems.
2. To perform advanced Data Preprocessing tasks like Data Merging and Mugging
3. To be able to develop powerful Web-Apps using Python

Course Outcome:

1. Understand the nuances of Data Structures
2. Derive an understanding of a classes and objects and their potential
3. Gain knowledge of multithreading concepts and implementing the same
4. Appreciate the difference between different data processing techniques
5. Learn to apply Python features for Data Science
6. Get an insight into Metrics Analysis
7. Develop web-apps and build models for IoT

Student Learning Outcomes (SLO): **1, 5, 14**

Module:1	**Data Structures**	**4 Hours**

Problem solving using Python Data Structures : LIST, DICT, TUPLES and SET- Functions and Exceptions – Lamda Functions and Parallel processing – MAPS – Filtering - Itertools – Generators

Module:2	**Classes and Objects**	**4 Hours**

Classes as User Defined Data Type ,Objects as Instances of Classes, Creating Class and Objects, Creating Objects By Passing Values, Variables & Methods in a Class Data Abstraction, Data Hiding, Encapsulation, Modularity, Inheritance, Polymorphism

Module:3	**Multithreading in Python**	**4 Hours**

Python Multithreading and Multiprocessing Multithreading and multiprocessing Basics – Threading module and example – Python multithreading - Multithreaded Priority Queue

Module:4	**Data Processing**	**5 Hours**

Handling CSV, Excel and JSON data - Creating NumPy arrays, Indexing and slicing in NumPy, Downloading and parsing data, Creating multidimensional arrays, NumPy Data types, Array Attribute, Indexing and Slicing, Creating array views copies, Manipulating array shapes I/O – MATPLOT LIB

Module:5	**Data Science Perspectives**	**4 Hours**

Using multilevel series, Series and Data Frames, Grouping, aggregating, Merge DataFrames, Generate summary tables, Group data into logical pieces, Manipulate dates, Creating metrics for analysis

Module:6	**Data Handling Techniques**	**3 Hours**

Data wrangling ,Merging and joining,- Loan Prediction Problem, Data Mugging using Pandas

Module:7	**Web Applications**	**4 Hours**

Web Applications With Python – Django / Flask / Web2Py – Database Programming – NoSQL databases - Embedded Application using IOT Devices - Building a Predictive Model for IOT and Web programming

Module: 8	**Recent Trends**	**2 Hours**
	Total Hours	**30 Hours**

Text Book(s)

1	Doug Farrell, The Well Grounded Python Developer; Manning Publications, 2021
2	Paul Barry, Head-First Python, O-Reilly Media, 2016

Reference Book(s)	
1	Zed A Shaw, Learn Python the Hard Way - A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code, Addison Wesley Press, 2013
2	Eric Mathews, Python Crash Course, Second Edition, No Starch Press, 2019
3	Michael Kennedy, Talk Python: Building Data-Driven Web Apps with Flask and SQLAlchemy, Manning Publications, 2020

List of Experiments	Hours
1. Working with very large integers/different Data Formats	2 Hour
2. Rewriting an immutable string/String Manipulation	2 Hour
3. Using the Unicode characters that aren't in the keyboard	2 Hour
4. Encoding strings- ASCII and UTF 8	2 Hour
5. Writing list related type hints	4 Hours
6. Building sets with literals, adding, comprehensions and operators	4 Hours
7. Extending a built-in collection – a list that does statistics	4 Hours
8. Using properties for lazy attributes	4 Hours
9. Creating a breadboard prototype Circuit for IoT Program	6 Hours
10. Creating complex structures – maps of lists	6 Hours
11. Using Flask framework for RESTful APIs	6 Hours
12. Implementing authentication for Web Services	6 Hours
13. Application Integration	6 Hours
14. Combining many applications using Command Design Pattern	6 Hours
Total Hours	**60 Hours**

Mode of Evaluation: Project/Activity			
Recommended by Board of Studies		11-02-2021	
Approved by Academic Council	No.61	Date	18-02-2021

CSI3008	Internet of Everything	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. Understand the definition and significance of the Internet of Things.
2. Discuss the architecture, operation, communication protocols, and business benefits of an IoT solution.
3. Hands on experience with microcontroller IDE with Wi-Fi module to connect with a variety of sensors to collect the data.

Course Outcome:

1. Identify the IoT networking components with respect to OSI layer.
2. Design and develop IoT based applications.
3. Select the suitable communication protocol and software for the application.
4. Develop an application using microcontroller IDE with Wi-Fi module in order to communicate with various cloud services.
5. Analyze the data collected from sensors using machine learning approaches with the support of python programming.

Student Learning Outcomes (SLO): 2,5,6

Module:1	Introduction to Internet of Things	5 Hours

Introduction to IoT - Sensing, Actuation, Networking basics, Communication protocols, Sensor networks, M2M Communications, IoT characteristics. IoT Architecture - IoT functional blocks, Physical design of IoT, Logical design of IoT and Communication models.

Module:2	An IoT Architectural Overview	6 Hours

An Architectural Overview - An IoT architecture outline, Main design principles and needed capabilities, standards considerations. IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

M2M and IoT technology fundamentals - Devices and gateways, Local and wide area networking, Data management, Business process in IoT, Everything as a service (XaaS), M2M and IoT analytics, knowledge management.

Module:3	IoT Protocols and Point-to-Point Communication	7 hours

IoT protocols and softwares - MQTT, UDP, MQTT brokers, Publish-subscribe modes, HTTP, CoAP, XMPP, and Gateway protocols. IoT point-to-point communication technologies - Communication pattern, and IoT protocol architecture. Selection of wireless technologies - LoWPAN, Zigbee, WiFi, BLE, SIG, NFC, LoRa, LiFi, and WiDi.

Module:4	Programming with Microcontrollers	6 hours

Architecture of Microcontroller IDE, Setup the Microcontroller IDE, Developing a Microcontroller program, libraries, Basics of embedded C programming for Microcontroller, Interfacing with sensors & actuators - LED, push button, ultrasonic, and buzzer, Arduino interfacing with LCD, Working with digital and analog sensors - Temperature, Gas, Humidity, Motion, and Light sensors.

Module:5	Advanced Programming with Microcontrollers	7 hours

Microcontroller interfacing with Relay Switch and Servo Motor, Basic networking with ESP8266 WiFi module, Microcontroller interfacing with Wi-Fi module, TinkerCAD simulation, Thing speak cloud synchronization with Wi-Fi module, Posting data to Thinkspeak cloud, Receiving data from Thing speak, Various other cloud services available in the market.

Module:6	Developing IoT Solutions	8 hours

Comparison of various Rpi Models, Understand SoC architecture, Raspberry Pi Pin description, Raspberry Pi on-board components, Rpi operating system and Linux commands, First boot

and basic configuration, Introduction to python - keywords, operators, data structures, flow control, and python libraries, Sensor interfacing - Temperature and humidity sensor (DHT11), and Ultrasonic sensor.		
Module:7	**Case Studies**	**4 hours**
Smart city, Smart health monitoring system, Smart irrigation system for farmers, Smart security for home, and Smart electrical appliances at Home.		
Module:8	**Recent Trends**	**2 hours**
	Total hours:	**45 hours**

Text Book(s)	
1.	Cirani, S., Ferrari, G., Picone, M., & Veltri, L.. Internet of things: architectures, protocols and standards. John Wiley & Sons, 2018.
2.	Serpanos, D., & Wolf, M.. Internet-of-things (IoT) systems: architectures, algorithms, methodologies. Springer, 2017.
Reference Books	
1.	Hanes, D., Salgueiro, G., Grossetete, P., Barton, R., & Henry, J.. IoT fundamentals: Networking technologies, protocols, and use cases for the internet of things. Cisco Press. (2017)
2.	Blum, Jeremy. Exploring Arduino: tools and techniques for engineering wizardry. John Wiley & Sons, 2019.
3.	Dennis, Andrew K. Raspberry Pi home automation with Arduino. Packt Publishing Ltd, 2013.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Experiments		
1.	The process of setting up a platform for Microcontroller programming.	3 hours
2.	Write a program in to display binary pattern on three LEDs	2 hours
3.	Design an experiment to identify the room temperature and humidity and turn on/off the LED based on the threshold considered.	2 hours
4.	Write a program to interface with Bluetooth sensor that switches ON/OFF the LED based on the input 0/1.	3 hours
5.	Write a program to interface with temperature and humidity sensors and store the information in Thingspeak cloud.	3 hours
6.	Write a program to rotate the servo motor in clockwise or anti-clockwise direction based on the value received from Thinkspeak cloud. If input is 0, then clockwise. Else, anti-clockwise.	3 hours
7.	Write a program to display the level of garbage bin in the smartphone, and Thingspeak based on the information received from the bin using an ultrasonic sensor.	3 hours
8.	Write a program to collect the temperature or humidity information.	2 hours
9.	Write a program to turn on/off the LED based on the pushbutton input.	2 hours
10.	Write a program to collect the information from temperature sensor and send it to MQTT broker.	3 hours
11.	Implement a Theft detection application.	4 hours
	Total Laboratory Hours	**30 hours**

Mode of evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3009	Advanced Wireless Networks	L	T	P	J	C
		3	0	2	0	4
Pre-requisite		**Syllabus version**				
		1.0				

Course Objectives:

1. To study about advanced wireless network, LTE, 4G and Evolutions from LTE to LTEA.
2. To study about wireless IP architecture, Packet Data Protocol and LTE network architecture.
3. To study about wireless protocols, Mobility Management and Wireless Security.

Course Outcome:

1. Learn the latest 4G networks and LTE
2. Understand about the wireless standards and design.
3. Understand about the wireless network architecture and its concepts.
4. Learn wireless Technologies and protocols
5. Understand about the mobility management and cellular network.
6. Learn the security concepts of wireless networks and also the recent trends.

Student Learning Outcomes (SLO):	**2, 5 6**	
Module:1	**Introduction**	**7 hours**
Introduction to 1G/2G/3G/4G Terminology. Evolution of Public Mobile Services -Motivation for IP Based Wireless Networks -Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTEA		
Module:2	**Standards and Design**	**5 hours**
Wireless systems and standards. Wireless LANs: Wireless LAN technology. Wireless standard (IEEE 802.11 etc.) and Other IEEE 802.11 Standards		
Module:3	**Wireless Architectures**	**7 hours**
3GPP Packet Data Networks - Network Architecture - Packet Data Protocol (PDP) Context - Configuring PDP Addresses on Mobile Stations - Accessing IP Networks through PS Domain – LTE network Architecture - Roaming Architecture- Protocol Architecture		
Module:4	**Wireless technologies**	**7 hours**
Cellular wireless networks and systems principles. Antennas and radio propagation. Signal encoding and modulation techniques., advanced modulation and coding, medium access techniques, cognitive radio and dynamic spectrum access networks, Static and dynamic channel allocation techniques		
Module:5	**Wireless Protocols**	**6 hours**
MAC Protocols, The Mediation Device Protocol, Contention based protocols - PAMAS, Schedule based protocols – LEACH, IEEE 802.15.4 MAC protocol, Challenges and Issues in Transport layer protocol. Routing protocols- data centric routing protocols, hierarchical routing protocols, location based routing, energy efficient routing.		
Module:6	**Mobility Management**	**5 hours**
Cellular Networks-Cellular Systems with Prioritized Handoff-Cell Residing Time Distribution Mobility Prediction in Pico- and Micro-Cellular Networks		
Module:7	**Wireless Network Security**	**6 hours**
Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Distribution and Management, Secure Routing		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Ayman ElNashar, Mohamed El-saidny, Mahmoud Sherif, "Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach", John Wiley & Sons, 2014.
2.	W. Stallings, "Wireless Communications and Networks", 2nd edition, Pearson Education, 2013.
.	
Reference Books	
1.	Dharma Prakash Agrawal and Qing-An Zeng, "Introduction to Wireless and Mobile Systems", 3rd edition ,Tomson, , 2011.
2.	Theodore S. Rappaport, "Wireless Communications -Principles Practice",2nd edition, Prentice Hall of India, New Delhi, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Experiments (Indicative)		
1.	Connecting WIFI TO BUS(CSMA) Architecture	4 hours
2.	Creating WIFI SIMPLE INFRASTUCTURE MODE	4 hours
3.	Creating WIFI SIMPLE ADHOC MODE	4 hours
4.	Connecting WIFI TO WIRED BRIDGING	4 hours
5.	Creating WIFI TO LTE(4G) CONNECTION	6 hours
6	Creating A SIMPLE WIFI ADHOC GRID	4 hours
7	Learning GSM architecture.	4 hours
	Total Laboratory Hours	**30 hours**
Mode of evaluation:		

Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3010	Data Warehousing and Data Mining	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	Nil	Syllabus Revision				
		1.0				

Course Objectives:

1. To introduce the concept of Data Warehousing and Data Mining
2. To develop the knowledge for application of the mining algorithms for association, clustering
3. To explain the algorithms for mining data streams and the features of recommendation systems.

Course Outcomes:

1. Interpret the contribution of data warehousing and data mining to the decision-support systems
2. Apply the link analysis and frequent item-set algorithms to identify the entities on the real world data
3. Apply the various classifications techniques to find the similarity between data items
4. Analyse the various data mining tasks and the principle algorithms for addressing the tasks
5. Evaluate and report the results of the recommended systems
6. Design the model to sample, filter and mine the Streaming data
7. Analyse the various data mining tasks for multimedia and complex data.

Student Learning Outcomes:	2, 9, 12

Module 1	Data Warehouse	4 Hours

Introduction: Data Warehouse and OLAP Technology for Data Mining: Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Further Development of Data Cube Technology, From Data Warehousing to Data Mining Data Cube Computation and Data Generalization: Efficient Methods for Data Cube Computation, Further Development of Data Cube and OLAP Technology, Attribute-Oriented Induction.

Module 2	Data Preprocessing	4 Hours

Data, Types of Data, Attributes and Measurement, Types of Data Sets, Data Quality, Measurement and Data Collection Issues, Issues Related to Applications, Data pre-processing, Aggregation, Sampling, Dimensionality Reduction, Feature Subset Selection, Feature Creation, Discretization and Binarization, Variable Transformation, Similarity and Dissimilarity between Simple Attributes, Dissimilarities between Data Objects, Similarities between Data Objects.

Module 3	Association Analysis: Concepts and Algorithms	7 Hours

Frequent Itemset Generation, The Apriori Principle, Apriori Algorithm- Rule Generation-Candidate Generation and Pruning, Support Counting, Computational Complexity, Confidence-Based Pruning, Compact Representation of Frequent Itemsets, Maximal and Closed Frequent Itemsets, Alternative Methods for Generating Frequent Itemsets, FP-Growth Algorithm, FP-Tree Representation, Evaluation of Association Patterns, Handling Categorical Attributes, Handling Continuous Attributes, Discretization-Based Methods, Statistics-Based Methods, Non-discretization Methods, Sequential Pattern Discovery.

Module 4	Classification and Prediction	7 Hours

Classification - issues regarding classification and prediction -Decision Tree Induction-Bayesian classification – Support Vector Machines, Rule-Based Classification- Associative Classification Prediction, Rationale for Ensemble Method, Methods for Constructing an Ensemble Classifier, Bias-Variance Decomposition, Bagging, Boosting, Random Forests, Empirical Comparison among Ensemble Methods

Module 5	Cluster Analysis and Outlier Analysis	7 Hours

Types of Data in cluster analysis, - Major clustering methods- The k-Means Method, Agglomerative Hierarchical Clustering, Cluster Evaluation, Outlier Analysis- Distance-Based Outlier Detection- Density-Based Local Outlier Detection

Module 6	**Mining of Stream Data**	7 Hours
Mining Streams, Time Series and Sequence Data: Mining Data Streams, Mining Time-Series Data, Mining Sequence Patterns in Transactional Databases, Mining Sequence Patterns in Biological Data, Graph Mining, Social Network Analysis and Multirelational Data Mining		
Module 7	**Multimedia and Complex Data Mining**	7 Hours
Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Spatial Data Mining, Multimedia Data Mining, Text Mining, Mining the World Wide Web.		
Module 8	**Recent Trends**	**2 Hours**
	Total Hours:	**45 Hours**

TEXT BOOKS:

1. Bhatia, Parteek, "Data mining and data warehousing: principles and practical techniques". Cambridge University Press, Ist Edition, 2019.
2. Karaa, Wahiba Ben Abdessalem, and Nilanjan Dey. *Mining multimedia documents*. CRC Press, 2017.

REFERENCE BOOKS:

1. Igual, Laura, and Santi Seguí. "Introduction to Data Science." In Introduction to Data Science, Springer, Cham, 2017.
2. Gupta, Gopal K. Introduction to data mining with case studies. PHI Learning Pvt. Ltd., 2014.
3. M. Kantardzic, "Data Mining: Concepts, Models, Methods, and Algorithms", 2nd edition,
   Wiley-IEEE Press, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Experiments

1.	Build Data Warehouse and Explore WEKA	3 hours
2.	Introduction to exploratory data analysis using R	3 hours
3.	Demonstrate the Descriptive Statistics for a sample data like mean, median, variance and correlation etc.,	3 hours
4.	Demonstrate Missing value analysis and different plots using sample data.	3 hours
5.	Demonstration of apriori algorithm on various data sets with varying confidence (%) and support (%).	3 hours
6.	Demo on Classification Techniques using sample data Decision Tree, ID3 or CART.	3 hours
7.	Demonstration of Clustering Techniques K-Mean and Hierarchical.	3 hours
8.	Demo on Classification Technique using KNN.	3 hours
9.	Demonstration on Document Similarity Techniques and measurements.	3 hours
10.	Demo on Classification Technique for multimedia data	3 hours
	Total Hours:	**30 Hours**

Mode of evaluation: Project/Activity

Recommended by Board of Studies	Date: 11-02-2021		
Approved by Academic Council	No.61	Date:	18-02-2021

CSI3011	Computer Graphics and Multimedia	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**NIL**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the fundamental concepts of graphics and multimedia.
2. To acquire and implement the learning relate to 2D and 3D concepts in graphics programming.
3. To comprehend the elementary 3D modeling and rendering techniques.
4. To analyze the fundamentals of multimedia towards its representations, perceptions, communication and applications.

Course Outcome:

1. Interpret the basic components of the graphics system and the color models.
2. Design and demonstrate the basic graphical output primitives.
3. Perform two and three dimensional transformations and viewing
4. Describe and apply methods to model and render 3D objects.
5. Identify and describe the function of the general skill sets in the multimedia systems..
6. Expand the knowledge about the multimedia and its communication standards.

Student Learning Outcomes (SLO):	**2,9,11**	
Module:1	**Graphical Concepts and Display Systems**	**6 hours**

Graphics Systems: Video Display Devices – Types – Raster-Scan Systems and Random-Scan Systems – Input Devices – Hard-Copy Devices – Graphics Software; color models.

Module:2	**Output Primitives**	**6 hours**

Output Primitives: Points and lines − Line Drawing Algorithm: DDA and Bresenham's Algorithm − Midpoint Circle Generating Algorithm − Line Attributes − Color and Grayscale Levels.

Module:3	**2-D Geometrical Transformations and Viewing**	**7 hours**

Basic Transformations – Matrix Representations and Homogeneous Coordinates – Composite Transformations; Viewing: pipeline – Window-to- Viewport Coordinate Transformation; Clipping: point, line and polygon clipping algorithms

Module:4	**3-D Geometrical Transformations and Viewing**	**6 hours**

Three dimensional concepts; 3-D transformations: Basic, Other and Composite Transformations; Viewing: Parallel and Perspective Projections

Module:5	**Modeling and Rendering Techniques**	**6 hours**

Visible surface determination - Z-Buffer method, Scan line method, Depth sorting Method, raytracing, Shading Model - Gouraud and Phong Shading.

Module:6	**Multimedia System Design**	**6 hours**

Multimedia basics − Components of Multimedia − Multimedia applications – Multimedia Authoring − Hypermedia.

Module:7	**Multimedia and Communication Standards**	**6 hours**

Digitization of Sound − Quantization of Audio − Transmission of Audio − Multimedia communication standards − JPEG, MPEG**.**

Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Hearn, Donald, M. Pauline Baker, and Warren R. Carithers. Computer graphics with OpenGL. Upper Saddle River, NJ: Pearson Prentice Hall, 2014. [Module 1 - Module 5]
2. Steinmetz, Ralf, and Klara Nahrstedt. Multimedia systems. Springer Science & Business Media, 2013.

Reference Books				
1	F.S.Hill,Computer Graphics using OPENGL, Second edition, Pearson Education, 2009			
2	John F. Hughes, Andries Van Dam, Morgan Mc Guire ,David F. Sklar , James D. Foley, Steven K. Feiner and Kurt Akeley, Computer Graphics: Principles and Practice, 3rd Edition, AddisonWesley Professional, 2013.			
3	Kamisetty Rao, Zoran Bojkovic, Dragorad Milovanovic, Introduction to Multimedia Communications: Applications, Middleware, Networking, Wiley, ISBN: 978-0-471-46742-7			
4	Pakhira, Malay K. Computer graphics, multimedia and animation. PHI Learning Pvt. Ltd., 2010.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Experiments				
1.	Learning of Graphics Programming Environment and usage of Graphics APIs.			2 hours
2.	Implementation of Line Drawing algorithms			4 hours
3.	Implementation of Circle Drawing algorithm			2 hours
4.	Implementation of Line clipping algorithms against the given rectangular window.			4 hours
5.	Implement the 2-D transformations functions on 2-D graphic objects.			4 hours
6	Implement the function for the following 3-D transformation of a 3-D object			2 hours
7	Modelling and visualization of real-world /artificial scene using 2D graphics primitives			4 hours
8	Create a 2D animation using 2D modelling software.			8 hours
			Total Laboratory Hours	**30 hours**
Mode of evaluation: CAT / Assignment / Quiz / FAT / Project				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18-02-2021	

CSI3012	Distributed Systems	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	Nil	**Syllabus version**				
		1.0				

Course Objectives:

1. To provide students with contemporary knowledge in distributed systems
2. To equip students with skills to analyze and design distributed applications.
3. To provide master skills to measure the performance of distributed synchronization algorithms

Course Outcome:

1. Elucidate the foundations and issues of distributed systems
2. Understand the various synchronization issues and global state for distributed systems.
3. Implement the Mutual Exclusion and Deadlock detection algorithms in distributed systems
4. Explore the agreement protocols and fault tolerance mechanisms in distributed systems.
5. Describe the features of peer-to-peer and distributed shared memory systems
6. Demonstrate the concepts of Resource and Process management and synchronization algorithm

Student Learning Outcomes (SLO):	**2,5**	
Module:1	**Introduction**	**6 hours**

Introduction to Distributed Systems - Examples –Trends in Distributed Systems – Focus on resource sharing – System Models – Networking and Internetworking – Inter process Communications.

Module:2	**Distributed objects and Remote invocation**	**6 hours**

Publish-subscribe system – message queues – shared memory approach. Remote procedure call – distributed objects-communication between distributed objects – RMI – JSON-RMI

Module:3	**Message Ordering and Snapshots**	**7 hours**

Message ordering and group communication: Message ordering paradigms -Asynchronous execution with synchronous communication -Synchronous program order on an asynchronous system -Group communication – Causal order (CO) – Total order. Global state and snapshot recording algorithms: Introduction -System model and definitions -Snapshot algorithms for FIFO channels

Module:4	**Distributed Mutex and Deadlock**	**6 hours**

Distributed mutual exclusion algorithms: Introduction – Preliminaries – Lamports algorithm - Ricart-Agrawala algorithm Deadlock detection in distributed systems: Introduction – System model – Preliminaries -Models of deadlocks – Knapps classification – Algorithms for the single resource model

Module:5	**Concurrency control**	**6 hours**

Distributed deadlock – Resource allocation model - requirements and performance metrics - classification of distributed deadlock detection algorithm

Module:6	**Peer To Peer and Distributed Shared Memory**	**6 hours**

Peer-to-peer computing and overlay graphs: Introduction – Data indexing and overlays – Chord – Content addressable networks – Tapestry. Distributed shared memory: Abstraction and advantages – Memory consistency models -Shared memory Mutual Exclusion.

Module:7	**Process and Resource Management**	**6 hours**

Process Management: Process Migration: Features, Mechanism – Threads: Models, Issues, Implementation. Resource Management: Introduction- Features of Scheduling Algorithms –Task Assignment Approach – Load Balancing Approach – Load Sharing Approach.

Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)				
1.	Tanenbaum A.S., Van Steen M., "Distributed Systems: Principles and Paradigms", Third Edition,Pearson Education, 2017.			
2.	George Coulouris, Jean Dollimore and Tim Kindberg, Distributed Systems Concepts and Design, Fifth Edition, Pearson Education, 2012.			
Reference Books				
1.	Randy Chow an d Theodore Johnson , "Distributed Operating Systems and Algorithms", Addison - Wesley, - Fourth Impression - 2012			
2	Mukesh Singhal and N. G. Shivaratri, Advanced Concepts in Operating Systems, Distributed, Database, and Multiprocessor Operating Systems, McGraw Hill, 2008.			
3	Pradeep K. Sinha, "Distributed Operating Systems: Concepts & Design", PHI, 2008			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Challenging Experiments (Indicative)				
1.	Implementation of Chat application using socket programming Implementation of Remote Method Invocation			4 hours
2.	Implementation of Client-Server architecture using Socket Programming Implement Concurrent Echo Client Server Application			5 hours
3.	Write the Programs for Remote Procedure call. Implementation of Mutual Exclusion algorithms			5 hours
4.	Illustrate the message passing Interface for remote computation in distributed applications.			5 hours
5.	Idealize the working concepts behind distributed mutual exclusion algorithms through simulations.			6 hours
6	Illustrate the message passing Interface for remote computation in distributed applications.			5 hours
			Total Laboratory Hours	**30 hours**
Mode of evaluation:				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18-02-2021	

CSI3013	Blockchain Technologies	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. To provide a conceptual understanding on the function of Blockchain.
2. To discuss the functional elements of the bitcoin and its mining process.
3. To introduce the Ethereum and solidity platform
4. To understand how blockchain is applied to different aspects of the business.
5. To describe current Hyperledger projects and cross-industry use cases

Course Outcome:

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

1. Understand the basics of cryptographic hash functions and blockchain
2. Demonstrate the functional blocks of the bitcoin and cryptocurrencies
3. Describe the consensus algorithms and its challenges
4. Design the distributed application using Ethereum platform
5. Construct the solution by design and development of the smart contract using solidity
6. Identify and select suitable blockchain based applications
7. Analyze the challenges and issues in blockchain applications

Student Learning Outcomes (SLO): 1, 6, 7

Module:1	Blockchain Foundations	7 hours

Blockchain & Distributed Ledger Technology (DLT) - Elements of Distributed Computing: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table - Elements of Cryptography: Hash function, Properties of a hash function, Puzzle friendly Hash, Collison resistant hash, digital signatures, public key crypto, verifiable random functions - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof, Hash pointer and Merkle tree.

Module:2	Bitcoin and Cryptocurrency	7 hours

A basic crypto currency, Creation of coins, Payments and double spending, FORTH – the precursor for Bitcoin scripting, Bitcoin - Wallet - Blocks - Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay

Module:3	Distributed Consensus	7 hours

Consensus introduction -Consensus in a Bitcoin network - Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain - Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.

Module:4	Hyper Ledger Fabric & Etherum	7 hours

Architecture of Hyperledger fabric v1.1-Introduction to hyperledger fabric v1.1, chain code-Ethereum: Ethereum network, EVM, Transaction fee, Mist Browser, Ether, Gas, Solidity, Smart contracts, TruffleDesign and issue Crypto currency, Mining, DApps, DAO

Module:5	Smart Contracts	7 hours

Smart Contract Basics - Processing Smart Contracts - Deploying Smart Contracts - Solidity: Structure, Basic Data Types & Statements, Access Modifiers & Applications - Best Practices: Evaluating Smart Contracts

Module:6	Blockchain Applications	5 hours

Blockchain and Enterprise - Use Case: Blockchains for Trade Finance, Blockchains for Supply Chain Financing, Cross Border Connectivity - Trusted Data Transfer, Capital Markets, Government Services & Sustainable Livelihood, Ownership and property rights, Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain

- Blockchain Tradeoffs across Multichain, Ripple, Corda, EOS & Cosmos Facebook Libra & Corporate Currencies - CBDC & its paradoxes				
Module:7	**Blockchain Challenges and Constraints**			**3 hours**
Blockchain risks - Technological challenges - Standards - Scalability issues - Security and privacy - Legal and regulatory problems - Social and cultural constraints - The future of blockchain technology, AI, and digital privacy				
Module:8	**Recent Trends**			**2 hours**
	Total hours:			**45 hours**
Text Book(s)				
1	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.			
Reference Books				
1	Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks by Bashir, Imran,2017.			
2	Antonopoulos, A. M. (2014). Mastering Bitcoin: unlocking digital cryptocurrencies. "O'Reilly Media, Inc.".			
3	Franco, P. (2014). Understanding Bitcoin: Cryptography, engineering and economics. John Wiley & Sons.			
4	Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015.			
Mode of Evaluation:CAT/ Digital Assignments/Quiz/FAT/ Project.				
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18-02-2021	

CSI3014	Software Verification and Validation	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**				
		1.0				

Course Objectives:

1. To introduce the essential software engineering concepts involved
2. To impart skills in the design and implementation of efficient software systems across disciplines
3. To familiarize engineering practices and standards used in developing software products and components

Course Outcome:

1. Apply the principles of the engineering processes in software development.
2. Demonstrate software project management activities such as planning, scheduling and Estimation.
3. Model the requirements for the software projects.
4. Design and Test the requirements of the software projects.
5. Implement the software development processes activities from requirements to validation and verification.
6. Apply and evaluate the standards in process and in product.

Student Learning Outcomes (SLO):	**1,5,6**

Module:1	**Overview of Software Engineering**	**5 hours**

Introduction to Software Engineering - Software Development Life Cycle-Process Models in Software Testing

Module:2	**Testing Tools & Measurement**	**4 hours**

Introduction to Requirements Engineering Process - System Modeling - Requirement Validation-Introduction to Software Testing- Failure, Error, Fault, Defect, Bug Terminology- Skills for Software Tester- Limitations of Manual Testing and Need for Automated Testing Tools-Features of Test Tool: Guideline for Static and Dynamic Testing Tool- Advantages and Disadvantages of Using Tools- Selecting a Testing Tool- When to Use Automated Test Tools, Testing Using Automated Tools-What are Metrics and Measurement: Types of Metrics, Project Metrics, Progress and Productivity Metrics.

Module:3	**Software Design & Defect Management**	**6 hours**

Design Concepts- Formal Specifications- Verifying the implementation against the specification-Introduction, Defect Classification-Defect Management Process-Defect Life Cycle, Defect Template- Estimate Expected Impact of a Defect, Techniques for Finding Defects, Reporting a Defect-Test Coverage-Traceability Matrix.

Module:4	**Software Verification & Validation**	**6 hours**

Introduction to Verification and Validation-Software Inspection-Automatic Static Analysis

Module:5	**Software Testing & Levels of Testing**	**6 hours**

Testing-Types of Testing - Test Plan- Test Design- Test Review- Software Testing Fundamentals. General characteristics of testing, seven principles of testing.

Module:6	**Test Selection & Minimization for Regression Testing**	**8 hours**

Regression testing- Regression test process-Initial Smoke or Sanity test- Selection of regression tests- Execution Trace- Dynamic Slicing- Test Minimization- Tools for regression testing- Ad hoc Testing: Pair testing- Exploratory testing- Iterative testing- Defect seeding.

Module:7	**Software Quality & Reliability**	**8 hours**

Software Quality and Reliability-Software defects tracking- Test Planning, Management, Execution and Reporting- Software Test Automation: Scope of automation- Design & Architecture for automation- Generic requirements for test tool framework- Test tool selection, Testing in Object Oriented Systems-Software Metrics.

Module:8	**Recent Trends**			**2 hours**
	Total Lecture hours:			**45 hours**
Text Book(s)				
1.	Roger Pressman, Software Engineering: A Practitioner's Approach, 8th Edition, McGraw-Hill, 2019.			
Reference Books				
1.	Ian Sommerville, Software Engineering, 9th Edition, Addision-Wesley, 2016			
3	William E. Lewis , Software Testing and Continuous Quality Improvement, Third Edition, Auerbach Publications, 2017			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
Recommended by Board of Studies:		11-02-2021		
Approved by Academic Council		No.61	Date:	18-02-2021

CSI3015	Software Project Management	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the importance of software project management and identify main stages and stakeholders of a software project
2. To explain the purpose of a project's planning documents and construct the scope statement and the work breakdown structure
3. To portray how the software can assist in project management and articulate what is involved in quality assurance, planning and control on projects
4. To demonstrate RUP, Microsoft project 2010 & open source software project management tools

Course Outcome:

At the end of course student should be able to

1. Actively participate or successfully manage a software development project by applying project management concepts
2. Demonstrate knowledge of project management terms and techniques
3. Analyze the Steps involved in analyzing the Software projects and concepts to meet the estimation of the software Projects.
4. Work on Microsoft project, IBM RUP & open source software project management tools.
5. Estimate the organizing team based on industry exposure.

Student Learning Outcomes (SLO):	**2,12,13**

Module:1	**Introduction to Project Management**	**7 hours**

Importance of software project management - Stages of Project - The Stakeholder of Project - Project Management Framework - Software Tools for Project Management – Microsoft Project 2010 – Software projects versus other types of project – Contract management and technical project management

Module:2	**Project Planning**	**6 hours**

Integration Management: Project Plan Development - Plan Execution Scope Management: Methods for Selecting Projects - Project Charter - Scope Statement - WBS. Stepwise Project Planning: Main Steps in Project Planning Use of Software to Assist in Project Planning Activities

Module:3	**Project Scheduling**	**7 hours**

Time Management: Importance of Project Schedules - Schedules and Activities - Sequencing and Scheduling Activity Project Network Diagrams: Network Planning Models - Duration Estimating and Schedule Development - Critical Path Analysis - Program Evaluation and Review Technique (PERT) Use of Software to Assist in Project Scheduling Activities - Software Metrics for Project Management: Metrics Sets for Project Management

Module:4	**Software Risk Management**	**7 hours**

Perspectives of Risk Management - Risk Definition – Risk Categories – Risk Assessment: Approaches, techniques and good practices – Risk Identification / Analysis / Prioritization – Risk Control (Planning / Resolution / Monitoring) – Risk Retention – Risk Transfer - Failure Mode and Effects Analysis (FMEA) – Operational Risks – Supply Chain Risk Management.

Module:5	**Project Cost Management**	**5 hours**

Project Cost Management: Importance and Principles of Project Cost Management - Resource Planning - Cost Estimating - Cost Budgeting - Cost Control - Use of Software to assist in Cost Management

Module:6	**Software Quality Management**	**5 hours**
Project Quality: Stages of Software Quality Management - Quality Planning - Quality Assurance - Quality Control – Quality Standards – Tools for Quality control		
Module:7	**People Management**	**6 hours**
Leadership styles – Developing Leadership skills – Leadership assessment – Motivating People – Organizational strategy – Management – Team building – Delegation – Art of Interviewing People - Team Management – Rewarding - Client Relationship Management - Organizational behavior: a background, Selecting the right person for the job –Instruction in the best methods– The Oldham-Hackman job characteristics model		
Module:8	**Recent Trends**	**2 hours**
	Total hours	**45 hours**

Text Book(s)	
1.	Information Technology Project Management, Kathy Schwalbe, Seven Edition 2013
2.	Software Project Management in Practice, Pankaj Jalote, Pearson, 2015.
Reference Books	
1	Murali Chemuturi, Thomas M. Cagley, —Mastering Software Project Management: Best Practices, Tools and Techniques, J. Ross Publishing, 2010
2.	Bole Hughes and Mike Cotterell, "Software Project Management", Tata McGraw Hill, Third Edition, 2002
3.	Microsoft Project 2010 Bible,Elaine Marmel

Mode of Evaluation:CAT/ Digital Assignments/Quiz/FAT/ Project.			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3016	Robotics: Machines and Controls	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To introduce the parts of robots, basic working concepts and types of robots
2. To make the students familiar with machine operations using robots
3. To discuss the applications and implementation of robot control systems

Course Outcome:

1. Explain the working principle of robots
2. Analyze the purpose of various sensor in robot for automation
3. Design and develop the robotic arm to handle the materials and machines
4. Understand the robot programming for control engineering
5. Conduct and design the experiments for various robot control operations

Student Learning Outcomes (SLO): **1,9,14**

Module:1	**Introduction**	**3 hours**

History of robots, robotics and programmable automation, laws of robotics, anatomy of robots, specifications of robots, Applications of robots, machine intelligence and flexible automation safety measures in robotics, AI in Robotics.

Module:2	**Robot Kinematics**	**7 hours**

Introduction, forward and reverse kinematics, robot arm and degrees of freedom, homogeneous transformation and DH parameters, dynamics of robot arm, kinematics of mobile robot

Module:3	**Actuators and Control**	**6 hours**

Robot drive system, functions of drive systems, pneumatic systems, electrical drives, DC motor, stepper motor, servo motor, need of sensing systems, types of sensors, robot vision system, robot end effectors, drive system for grippers, types of grippers, gripper design for machine control operations

Module:4	**Introduction to Mechatronics**	**6 hours**

Manufacturing industry, the changing environment, automation and mechatronics applications, flexible automation, CAD/CAM and CNC machine tools, Flexible manufacturing systems(FMS), robots in FMS

Module:5	**Programmable Logic Controllers**	**6 hours**

Introduction, basic structure of PLC, PLC classification, PLC operation, loading and unloading parts by robot, PC based controller introduction

Module:6	**Servo control in a Robot**	**6 hours**

Control loops, principles of servo control in a robot, PID control aspects, processor controlled digital servo system, introduction to transfer functions

Module:7	**Applications of Robots**	**9 hours**

Industrial control systems, introduction to automation, basic elements of automation, levels of automation, material handling and identification, production planning and control systems, introduction to quality control and inspection technologies,

Module:8	**Recent trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. S.R. Deb, "Robotics technology and flexible automation", THH-2009
2. Mikell.P.Groover, "Automation, Production Systems, and Computer Integrated Manufacturing" 4th edition Pearson 2016

Reference Books

1. Saeed B.Nikku, Introduction to robotics, analysis, control and applications, Wiley-India, 2nd

	edition 2011		
2.	Richared D.Klafter. Thomas Achmielewski and Mickael Negin, Robotic Engineering and Integrated Approach, Prentice Hall India-New Delhi-2001		
3.	John Craig, " Introduction to Robotics, Mechanics and Control" February 2017, Pearson		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3019	Advanced Data Compression Techniques	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. Learn the fundamental of advanced data compression techniques
2. To introduce students to basic applications, concepts, and techniques of Data Compression.
3. To develop skills for using recent data compression software to solve practical problems in a variety of disciplines.
4. To gain experience doing independent study and research.

Course Outcome:

1. Understand the importance of Data compression
2. Comprehend the idea of lossless and lossy compression
3. Understand the most common file formats for image, sound and video
4. Develop a reasonably sophisticated data compression application.
5. Select methods and techniques appropriate for the task
6. Develop the methods and tools for the given task

Student Learning Outcomes (SLO):	**2, 9, 17**

Module:1	**Introduction**	**7 hours**

Introduction to Compression techniques – Modeling and coding – Mathematical preliminaries for Lossless compression – Entropy – Information Value – Data Redundancy - Application of compression

Module:2	**Basic Concepts of Information Theory**	**6 hours**

Concepts of information theory – Models and Coding – Algorithmic information theory – Physical Models – Probability models – Markov models.

Module:3	**Arithmetic Coding**	**6 hours**

Shannon-Fano Algorithm – Huffman Algorithm – Adaptive Huffman Coding – Golomb codes – Rice codes – Tunstall codes – Applications of Huffman coding.

Module:4	**Loss Less Coding**	**6 hours**

Dictionary Methods: LZ77, LZ78, LZW Algorithms – Lossless Compression standards zip, gzip, bzip, unix compress, GIF, JBIG – Dynamic Markoy Compression.

Module:5	**Basics Of Lossy Coding &Vector Quantization**	**6 hours**

Basics of lossy coding and mathematical concepts – Distortion criteria – Scalar quantization – The Quantization problem – Uniform quantizer – Adaptive quantization – Advantages of vector quantization over scalar quantization – LBG algorithm.

Module:6	**Image & Video Compression**	**6 hours**

Image Compression: Discrete Cosine Transform – JPEG – Video Compression: Motion Compensation – Temporal and Spatial Prediction - MPEG and H.264.

Module:7	**Wavelet Based Compression**	**6 hours**

Fundamentals of wavelets –Various standard wavelet bases – Multi resolution analysis and scaling function – JPEG 2000.

Module:8	**Recent Trends**	**2 hours**
Total Lecture hours:		**45 hours**

Text Book(s)

1. Khalid Sayood, Morgan Kauffman Introduction to Data Compression, 5th Edition, Elsevier, 2020.

Reference Books			
1. Colton McAnlis, Aleks Haecky, Understanding Compression: Data Compression for Modern Developers, O'Reilly.2016. 2. Feng Wu, Advances in Visual Data Compression and Communication Meeting the Requirements of New Applications, Auerbach Publications 2014.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3020	Advanced Graph Algorithms	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the fundamental concepts and techniques of Graphs.
2. To comprehend the concepts of various graph algorithms
3. The module covers advanced material on graph algorithms with emphasis on efficient algorithms, and explores their use in a variety of application areas.
4. To understand the mathematical approaches of solving graph algorithms with the help of fundamental data structures.

Course Outcome:

1. Acquire the concept of conceptual and operations, properties on graphs.
2. Learn the concept of various graph algorithms and its uses.
3. Obtain the knowledge of Exponential algorithm
4. Analyze the graph classes and parameter Algorithm.
5. Implement the concepts approximation on various graph algorithms.

Student Learning Outcomes (SLO): **1, 5, 9**

Module:1	**Basics of Graph and Operations**	**4 hours**

Fundamental concepts - basic definitions of graphs and digraphs -Subgraphs and other graph types-Representing graphs as matrices- Graph transformation - operations, properties, proof styles

Module:2	**Graph Algorithms**	**6 hours**

Elementary Graph Algorithms -Representations of graphs - Breadth-first search - Depth-first search -Topological sort - Strongly connected components -Representing graphs in a computer - Minimum Spanning Trees - Growing a minimum spanning tree - The algorithms of Kruskal and Prim .

Module:3	**Shortest Path Algorithm**	**5 hours**

Single-Source Shortest Paths - The Bellman-Ford algorithm - Single-source shortest paths in directed acyclic graphs - Dijkstra's algorithm -Difference constraints and shortest paths - Proofs of shortest-paths properties - All-Pairs Shortest Paths -Shortest paths and matrix multiplication - The Floyd-Warshall algorithm - Johnson's algorithm for sparse graphs .

Module:4	**Maximum Flow**	**5 hours**

Maximum Flow - Flow networks - The Ford-Fulkerson method - Maximum bipartite matching - Push-relabel algorithms - The relabel-to-front algorithm.

Module:5	**Exponential Algorithm**	**7 hours**

Independent set-Chromatic Number-Domatic Partition-The travelling Salesman Problem-Set Cover- Dominating Set-Subset Sum.

Module:6	**Graph Classes and Fixed Parameter Algorithms**	**8 hours**

Perfect Graph-Cographs-Distance Hereditary graph-Chordal Graphs-Interval Graph-Permutation graphs-Vertex Cover-Kernel of Vertex cover-Minimum fill in-Homogeneous colouring of perfect graph.

Module:7	**Approximation Algorithms**	**8 hours**

Approximation Algorithms - The vertex-cover problem - The traveling-salesman problem - The set-covering problem - Randomization and linear programming - The subset-sum problem

Module:8	**Recent Trends**	**2 hours**
	Total hours:	**45 hours**

Text Book(s)

1. Tim Roughgarden "Algorithms Illuminated (Part 2): Graph Algorithms and Data Structures", First Edition , Soundlikeyourself Publishing LLC,Sanfrancisco,CA,2018.

2.	Thomas H. Cormen Charles E. Leiserson Ronald L. Rivest Clifford Stein, "Introduction to algorithm" 3rd Edition, The MIT Press Cambridge 2009.		
Reference Books			
1	A.V Aho, J.E. Hopcroft and J.D. Ullman. Design and Analysis of Computer Algorithms, Addison Wesley, 1974.		
2.	T.Kloks "Advance Graph Algorithms" – Kloks, 2012		
Mode of Evaluation: CAT/ Digital Assignments/Quiz/FAT/ Project.			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3021	Advanced Computer Architecture	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	CSI1004	Syllabus version				
		1.0				

Course Objectives:

1. Introduce the recent trends in the field of Computer Architecture and identify performance related parameters.
2. Apply fundamental techniques to speed-up program execution.
3. Expose the different types of multicore architectures and Programming.

Course Outcome:

1. Understand the organization and performance characteristics of modern computer architectures.
2. Interpret techniques to improve processor's ability to exploit Instruction Level Parallelism.
3. Point out how data level and thread level parallelisms is exploited in architectures.
4. Identify characteristics and challenges in multiprocessor and multicore architectures.
5. Develop parallel programming for computer problems.

Student Learning Outcomes (SLO):	2, 12, 14

Module:1	Introduction to Advanced Computer Design	5 hours

Fundamentals of Computer Design- Fundamentals of RISC, CISC architecture- Data path implementation-Single cycle Data path- Multi cycle data path-Multi cycle Instruction execution-Instruction Scheduling.

Module:2	Instruction Level Parallelism	8 hours

Introduction to Instruction Level Parallelism – Concepts and Challenges – Advanced Branch Prediction - Dynamic Scheduling – Static scheduling- Hardware-Based Speculation – Multithreading - Limitations of ILP.

Module:3	Data Level Parallelism	5 hours

Vector architecture – SIMD extensions – Graphical Processing Units and applications – Loop level parallelism.

Module:4	Multi-Threading Concepts	6 hours

Basic concepts of threading- Concurrency, Parallelism -Threading design concepts for developing an application- Correctness Concepts: Critical Region, Mutual exclusion, Synchronization, Race Conditions- Performance Concepts: Simple Speedup, Computing Speedup, Efficiency , Granularity , Load Balance

Module:5	Multi-Processor Architecture	6 hours

Need for multi-core architectures, Architecting with multi-cores, Homogenous and heterogeneous cores, Shared recourses, shared busses, and optimal resource sharing strategies. Performance evaluation of multi-core processors, Error management

Module:6	Multi core architecture	7 hours

Introduction- Centralized, Symmetric and Distributed Shared Memory Architectures –Cache Coherence Issues – Performance Issues – Synchronization – Models of Memory Consistency

Module:7	Multi Core and GPU Programming	6 hours

Multi core programming using OpenMP, OpenMP Directives, Parallel constructs, Work-sharing constructs, Data environment constructs, Synchronization constructs

Module:8	Recent Trends	2 hours
	Total hours:	45 hours

Text Book(s)

1. John L. Hennessey and David A. Patterson, –Computer Architecture – A Quantitative Approach, Morgan Kaufmann , Elsevier, 6th edition, 2017.

Reference Books			
1.Kai Hwang, Naresh Jotwani, Advanced Computer Architecture: Parallelism, Scalability, Programmability, Tata McGraw Hill Education Pvt. Ltd., India, Second Edition, 2011. 2. Barbara Chapman, Gabriele Jost, Ruud van van de Pas, Using OpenMP: Portable shared memory, parallel programming (scientific and engineering computation),, 1st Edition, MIT Press, 2008. 3. David B Kirk, Wen-mei W Hwu, Programing Massively Parallel Processors: A Handson Approach(Application of GPU Computing Series) , 2 nd Edition, Morgan Kaufmann,2013.			
Mode of Evaluation: CAT/ Digital Assignments/Quiz/FAT/ Project.			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

CSI3022	Cyber Security and Application Security	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		1.0				

Course Objectives:

1. To learn the concepts of number theory, Information and Network Security
2. To learn the basics of cryptography and cryptographic techniques.
3. To familiarize with various cyber threats, attacks, vulnerabilities, defensive mechanisms, security policies, practices
4. To learn how to implement application level security

Course Outcome:

After successfully completing the course the student should be able to

1. Know the fundamental mathematical concepts related to security
2. Know the basic concepts of information and network security
3. Understand and implement the cryptographic techniques and know the real time applications of various cryptographic techniques.
4. Know fundamentals of cybercrimes and the cyber offenses.
5. Understand the cyber threats, attacks, vulnerabilities and its defensive mechanisms
6. Design suitable security policies and know about the industry practices

Student Learning Outcomes (SLO):	1,5,9

Module:1	Number Theory Basics	5 hours

Finite Fields and Number Theory: Algebraic Structures(Groups)-Modular arithmetic – GCD using Euclidian Algorithm – Primality Testing – Fermat's and Euler's theorem –Chinese Reminder theorem – Discrete Logarithms

Module:2	Information and Network Security	6 hours

Introduction-Computer Security-Information Security-Security Threats and Vulnerabilities – Security Services – Security Mechanisms- Model for Network Security

Module:3	Cryptography Basics and Techniques	6 hours

Basics of Cryptography- Symmetric key cryptographic techniques: Introduction to Stream cipher – Block cipher: DES – AES-Asymmetric key cryptographic techniques: principles – RSA – ElGamal - Elliptic Curve cryptography – Key distribution and Key exchange protocols.

Module:4	Cybercrimes and Cyber offenses	7 hours

Classification of cybercrimes, Planning of attacks, Social Engineering:Human based, Computer based, Cyberstalking, Cybercafe and Cybercrimes

Module:5	Cyber Threats, Attacks and Prevention:	7 hours

Phishing – Password cracking – Keyloggers and Spywares – DoS and DDoS attacks – SQL Injection- Identity Theft (ID) : Types of identity theft – Techniques of ID theft

Module:6	Cybersecurity Policies and Practices	7 hours

What security policies are – Determining the policy needs – Writing security policies – Internet and email security policies – Compliance and Enforcement of policies- Review

Module:7	Application Security	5 hours

Security Architectures and Models- Email security-PGP and SMIME, Web Security, Database Security-Wireless Network Security

Module:8	Recent Trends	2 hours
	Total Lecture hours:	45 hours

Text Book(s)				
1. Cryptography and Network security, William Stallings, Pearson Education, 7th Edition, 2016 2. Network Security Essentials Applications and Standards, William Stallings, Pearson Education, 6th Edition, 2018 3.Cyber Security, Understanding cyber crimes, computer forensics and legal perspectives, Nina Godbole,Sunit Belapure, Wiley Publications, Reprint 2016				
Reference Books				
1. Cybersecurity for Dummies, Brian Underdahl, Wiley, 2011 2. Cryptography and Network security, Behrouz A. Forouzan , Debdeep Mukhopadhyay, Mcgraw Hill Education, 2nd Edition, 2011				
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Indicative Experiments				
1.	Analysis of security in Unix/Linux.			2 hours
2.	Administration of users, password policies, privileges and roles			2 hours
3.	Eavesdropping Attacks and its prevention using SSH			2 hours
4.	Deep Packet Inspection on IP/ICMP Vulnerabilities			2 hours
5.	Deep Packet Inspection on TCP/IP Vulnerabilities			4 hours
6.	Implement your design using Windows Folder structure to activate directory and computer to create security groups that meets your requirement			4 hours
7.	Group Policy Management to edit the default domain policy to a specific organization unit.			2 hours
8.	Create new rules in Windows firewall to allow the HTTP connection and verify that the new rules allow the HTTP incoming request.			2 hours
9.	Basic defensive practice skills against malicious SQL injection attacks in mobile software development.			2 hours
10.	Defense of Brute Force Approach of Gaining Access MySQL Database with Weak Authentication			2 hours
11.	Design a system to detect all the instances of an attack using signatures			4 hours
12.	Examine network traffic and identify potentially malicious traffic			2 hours
Total Laboratory Hours				**30 hours**
Recommended by Board of Studies		11-02-2021		
Approved by Academic Council		No. 61	Date	18-02-2021

CSI3027	R Programming	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the fundamentals of R programming.
2. To comprehend the various functions and structures of R.
3. To design systems based on graphics and analytics using R.

Course Outcome:

1. Understand the basics of R programming in terms of vectors, matrices and lists.
2. Understand the working of data frames, functions and tables using R.
3. Apply various programming structures in solving statistical problems.
4. Design Systems by interfacing R with other programming languages.
5. Design and implement models to perform analytics on the given dataset.
6. Apply the R programming from a statistical perspective over the real world problems.

Student Learning Outcomes (SLO):	**1, 7,14**	
Module:1	**Vectors in R**	**4 hours**
Introduction to R – R Data Structures – Help functions in R – Vectors – Scalars – Declarations – recycling – Common Vector operations – Using all and any – Vectorised operations – NA and NULL values – Filtering – Vectorised if-then else – Vector Equality – Vector Element names		
Module:2	**Matrices Arrays and Lists**	**5 hours**
Creating matrices – Matrix operations – Applying Functions to Matrix Rows and Columns – Adding and deleting rows and columns – Vector/Matrix Distinction – Avoiding Dimension Reduction – Higher Dimensional arrays – lists – Creating lists – General list operations – Accessing list components and values – applying functions to lists – recursive lists		
Module:3	**Data Frames and Tables**	**4 hours**
Creating Data Frames – Matrix-like operations in frames – Merging Data Frames – Applying functions to Data frames – Factors and Tables – factors and levels – Common functions used with factors – Working with tables - Other factors and table related functions		
Module:4	**Data Frames and Tables**	**5 hours**
Control statements – Arithmetic and Boolean operators and values – Default values for arguments - Returning Boolean values – functions are objects – Environment and Scope issues – Writing Upstairs - Recursion – Replacement functions – Tools for composing function code – Math and Simulations in R		
Module:5	**Object Oriented Programming and I/O**	**4 hours**
S3 Classes- S4 Classes - S3 Vs S4 classes -Managing Objects -accessing keyboard and monitor – reading and writing files – accessing the internet		
Module:6	**String Manipulation and Graphics**	**3 hours**
String Manipulation – Graphics – Creating Graphs – Customizing Graphs – Saving graphs to files – Creating three-dimensional plots.		
Module:7	**Interfacing**	**3 hours**
Interfacing R to other languages – Parallel R – Basic Statistics – Linear Model – Generalized Linear models, Non-linear models – Time Series and Auto-correlation – Clustering		
Module:8	**Recent Trends**	**2 hours**
	Total hours:	**30 hours**

Text Book(s)

1. Norman Matloff , "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press, 2011.
2. Wickham, H. & Grolemund, G. , "R for Data Science". O'Reilly, New York, 2018

Reference Books				
1	Gareth J,Daniela W,Trevor H & Robert T, "An Introduction to Statistical Learning: with Applications in R", Springer , 2017.			
2.	Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2018.			
Mode of Evaluation: CAT/ Digital Assignments/Quiz/FAT/ Project.				
List of Experiments (Indicative)				
1	Write a R program to implement common vector operations			2 Hours
2	Write a R program to implement matrix operations			2 Hours
3	Write a R program to implement multi-dimensional array operations			2 Hours
4	Write a R program to apply functions to lists			2 Hours
5	Write a R program to implement matrix-like operations in frames and merging data frames			2 Hours
6	Write a R program to implement factors ,levels and tables			2 Hours
7	Write a R program to implement control statements and arithmetic operations			2 Hours
8	Write a R program to implement replacement functions and recursion			2 Hours
9	Perform simulation of a mathematical function			2 Hours
10	Perform simulation of analytics of a statistical data			2 Hours
11	Write a R program for assessing key board and monitor			2 Hours
12	Write a R program to implement the reading and writing of files			2 Hours
13	Write a R program to implement the internet access			2 Hours
14	Write a R program to implement input and output data visualization using graphs.			2 Hours
15	Performing analytics of a linear model.			2 Hours
			Total	**30 Hours**
Recommended by Board of Studies	11-02-2021			
Approved by Academic Council	No. 61	Date	18.02.2021	

CSI3028	Deep Learning	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To present the basic ideas, mathematical and computational models of neural network.
2. To under the concepts of developing various deep learning models
3. To provide the knowledge to apply the deep learning models in various real world applications.

Course Outcome:

1. Recognize the characteristics and role of deep learning models.
2. Understand different deep learning models and develop the transfer learning models for solving real-world problems.
3. Design the sequence models for analyzing the data for variety of problems.
4. Design the deep models to encode the original data and reconstruct data.
5. Generate the generative models for unsupervised learning task.

Student Learning Outcomes (SLO):	**2,6,9**

Module:1	**Basics of Machine Learning**	**5 hours**

Learning Algorithms, Building machine learning algorithm, Biological Neuron, Neural Network, Linear separability, Linear perceptron, Stochastic Gradient Descent, Multilayer Perceptron, Back-propagation algorithm, Curse of Dimensionality.

Module:2	**Introduction to Deep Learning**	**7 hours**

Historical context and motivation of Deep Learning, Gradient-Based Learning, Multi-layer perceptron, Back-propagation, Vanishing Gradient Problem, Capacity, Overfitting and Underfitting, Activation Functions: RELU, LRELU, ERELU, Regularization- dropout, drop connect, optimization methods for neural networks- Adagrad, adadelta, rmsprop, adam, NAG.

Module:3	**Convolutional Neural Networks**	**6 hours**

Overview of Convolutional Neural Networks Architecture-Motivation, Layers, Kernels, Convolution operation, Padding, Stride, Pooling, Non-linear layer, Stacking Layers, Popular CNN Architectures: LeNet, AlexNet, ZFNet, VggNet..

Module:4	**Transfer Learning**	**6 hours**

Data Pre-processing, Data Augmentation, batch normalization, Transfer Learning, Deep Transfer Learning Strategies, variants of CNN: DenseNet, PixelNet, ResNet, GoogleNet, Xception.

Module:5	**Deep Recurrent Neural Network**	**7 hours**

Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures, Deep Recurrent Networks, Recursive Neural Networks, Long Short Term Memory Networks.

Module:6	**Auto Encoders**	**6 hours**

Autoencoders, Regulraized Autoencoders, Denoising Autoencoders, Representational Power, Layer, Size, and Depth of Autoencoders, Stochastic Encoders and Decoders, Contractive Encoders.

Module:7	**Deep Generative Models**	**6 hours**

Boltzmann Machines, Restricted Boltzmann Machines, Deep Belief networks, Deep Boltzmann Machine - Directed Generative Nets, Generative Adversial Networks.

Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)			
1.	Ian Goodfellow, YoshuaBengio and Aaron Courville**, " Deep Learning"**, MIT Press, 2017.		
Reference Books			
1.	Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017		
2.	Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.		
3.	Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of evaluation: Project/Activity			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18.02.2021

CSI3030	Internetworking with TCP/IP	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**				
		1.0				

Course Objectives:

1. To build an understanding of the fundamental concepts of Internetworking.
2. To explore and understanding TCP/IP.

Course Outcomes:

1. Describe the underlying network technologies and internetworking concept.
2. Understand the concepts of the network layer and design subnets.
3. Understand the concepts IPv4, IPv6, and various routing protocols.
4. Identify suitable transport layer protocols for real-time applications.
5. 5. Identify the suitable application layer protocols for specific applications.

Module:1	**Introduction and Underlying Network Technologies**	**6 hours**

The motivation for Internetworking, The TCP/IP Internet, Internet Services, History and Scope of the Internet, The Internet Architecture Board, The IAB reorganization, The Internet Society, Internet Request For Comments, Internet Protocols and Standardization, Future growth and technology.Two approaches to network communication, Wide Area and Local Area Networks, Ethernet technology

Module:2	**Internetworking concept and Architecture Model**	**4 hours**

Introduction, Application-level Interconnection, Network-Level Interconnection, Properties of the Internet, Internet Architecture, Interconnection through IP routers.

Module:3	**Network Layer**	**8 hours**

Switching, Packet Switching at the network layer, network layer services, other network layer issues, IPv4 addresses - Classful addressing, Classless addressing, special addresses, NAT, Datagrams, fragmentation, options, checksum, IPv6 Addresses.

Module:4	**Internet Protocol**	**5 hours**

IPv4 - Datagram, Fragmentation, Options, Checksum, Security, IPv6 Protocol - Introduction, Packet format, Transition from IPv4 to IPv6.

Module:5	**Unicast Routing Protocols**	**7 hours**

Introduction, Intra and Interdomain routing, Distance vector routing, RIP, Link state routing, OSPF, Path vector routing, BGP.

Module:6	**Transport Layer**	**8 hours**

User Datagram, UDP services, UDP applications, TCP services, TCP features, Segment, A TCP Connection, Windows in TCP, Flow control, Error control, Congestion control.

Module:7	**Application layer**	**5 hours**

Client-Server paradigm, Peer-to-Peer paradigm, DHCP operation, Configuration, TELNET, SSH, SNMP – Concept, Management components, SMI, MIB, SNMP.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Douglas. E.Comer, Internetworking with TCP/IP Principles, protocols, and architecture, Volume 1, 6th Edition, Pearson Education, 2013.

Reference Books

1. Computer Networking: A Top-Down Approach, Kurose and Rose, Morgan Kaufmann, 6th Edition 2012.
2. Computer Networks- A Systems Approach, Larry L. Peterson and Bruce S. Davie, Morgan Kaufmann, 2011,
3. Behrouz A Forouzan , TCP/IP Protocol Suite, 4th Edition, McGraw Hill Education, 2009.
4. Richard Stevens, Gary R Wright, TCP/IP illustrated – Volume 1: The protocol Addison-

	Wesley Professional; 2nd edition, 2011.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI3031	Quantum Computing Techniques	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the fundamental concepts on quantum computing.
2. To learn how to do computations using quantum algorithms.
3. 3. To perform reliable and secure information processing in quantum applications.

Course Outcome:

At the end of the course, the student can

1. Understand the basic concepts on quantum computing.
2. Familiarize with the algebraic notation used in the frameworks of quantum mechanics.
3. Design a simple quantum circuit model of computations.
4. Able to implement quantum basic and search algorithms for performing computations on quantum computers.
5. 5. Able to control the noise in quantum information processing systems and also able to do quantum information processing reliably in the presence of noise.

Module:1	**Introduction to Quantum Computing**	**5 hours**
History of quantum computation and quantum information – The Circuit Model of Computation - A Linear Algebra Formulation of the Circuit Model - Reversible Computation - Quantum Physics and Computation - Quantum bits: Multiple qubits.		
Module:2	**Linear Algebra and the Framework of Quantum Mechanics**	**7 hours**
The Dirac Notation and Hilbert Spaces - Dual Vectors – Operators - The Spectral Theorem - Functions of Operators - Tensor Products - The Schmidt Decomposition Theorem - The State of a Quantum System - Time-Evolution of a Closed System - Composite Systems – Measurement - Mixed States and General Quantum Operations.		
Module:3	**Quantum Model of Computation**	**7 hours**
The Quantum Circuit Model - Quantum Gates - 1-Qubit Gates - Controlled-U Gates - Universal Sets of Quantum Gates - Efficiency of Approximating Unitary Transformations - Implementing Measurements with Quantum Circuits – Quantum Communication Protocols: Superdense Coding - Quantum Teleportation - An Application of Quantum Teleportation		
Module:4	**Quantum Algorithms**	**5 hours**
Probabilistic Vs Quantum Algorithms - Deutsch's algorithm - The Deutsch–Jozsa algorithm – Simon's Algorithm.		
Module:5	**Quantum Search Algorithms**	**6 hours**
Introduction and the procedure - Geometric visualization - Performance - Quantum search as a quantum simulation - Quantum counting - Speeding up the solution of NP-complete problems - Quantum search of an unstructured database - Optimality of the search algorithm.		
Module:6	**Quantum Information**	**7 hours**
Quantum noise and quantum operations - Classical noise and Markov processes - Quantum operations – Examples – Applications – Limitations		
Module:7	**Quantum Error Correction**	**6 hours**
Introduction – The Shor code - Theory of quantum error-correction – Constructing quantum codes – Stabilizer codes - Fault-tolerant quantum computation		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information,

	Cambridge 10th Anniversary Edition, University Press, UK, 2010. (Module 1, 5, 6, 7).			
2.	P. Kaye, R. Laflamme, and M. Mosca, An Introduction to Quantum Computing, Oxford University Press, New York, 2006. (Module 2, 3, 4).			
Reference Books				
1.	Chris Bernhardt, Quantum Computing for Everyone, The MIT Press, Cambridge, Massachusetts, London, England, 2019.			
2.	Jack D.Hidary, Quantum Computing: AN Applied Approach, Springer, 2019.			
3.	Arthur O. Pittenger, An Introduction to Quantum Computing Algorithms, Springer, NY, 2000.			
	Authors, book title, year of publication, edition number, press, place			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
Recommended by Board of Studies	25-10-2021			
Approved by Academic Council	No.64	Date	16-12-2021	

CSI3032	Advances in Pervasive Computing	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To acquaint students with pervasive device hardware, platforms and communication technologies
2. To teach a student about location awareness approaches and technologies through context aware computing in pervasive computing
3. To explain the students about wearable computing and Web of Things (WoT)

Course Outcome:

1. Describe pervasive devices hardware, platforms and other computing
2. Evaluate efficiency trade-offs among alternative Communication models for pervasive computing applications
3. Comprehend advanced Pervasive computing Applications and Technologies from the basics of pervasive computing
4. Understand working principles of various pervasive concepts for different platforms
5. Compare various application business models of different domains
6. Estimate the cost of hardware and software for low cost design pervasive computing Applications

Module:1	**Pervasive Computing Concepts**	**7 hours**

Key Characteristics of Pervasive computing and its applications, Brief overview on sequential computing, parallel computing, distributed computing, grid computing, cloud computing, Location in ubiquitous computing, Context-aware computing, wearable computing, The Structure and Elements of Pervasive Computing Systems.

Module:2	**Hardware Components, Platforms and Technologies**	**7 hours**

Processor, Operating System: Android, iOS, Windows Mobile OS, BlackBerry OS; Displays: TFT LCD, IPS LCD, Retina Display, Touch Screen LCD, Resistive LCD, Capacitive LCD, OLED, OMLED, Super OMLED,, Haptic/Tactile, Gorilla Glass, Memory, Input, Connectivity, Extensibility, Camera, Enterprise Applications: Wireless Devices, Enterprise Applications, Wireless Technologies, Enterprise Architecture; Network Protocols and technologies: programming strategies, Mobile Communication Technologies: GSM , CDMA , LTE, Device and Communication characteristics, Basic terminology of the cellular telecommunication networks, Multiplexing, Switching, Technologies, Cellular Networks, GSM.

Module:3	**Location Awareness in Pervasive Computing**	**7 hours**

Network-centric approaches: Cell of Origin (COO), Angle of Arrival (AOA), E-OTD (Enhanced Observed Time Difference), Time of Arrival (TOA); Handset-centric Approaches: GPS (Global Position System)Services, GPS Architecture, Algorithms, DGPS, Hybrid Methods: GPS & Cell ID; Indoor Locations: Location Based on 802.11, Localization Accuracy Applications & Services, challenges.

Module:4	**Context Aware (CA) Computing**	**9 hours**

Definitions, Services, Principles of CA , The Context life-cycle, Architectures and Use-cases, Issues & Research challenges, Localization algorithms and technologies, APIs for Location-based services, Location-aware services, Location Intelligence & Spatial Data, types of spatial data analysis, APIs for Location-based services, Privacy in Location Aware Systems, Neighbor Awareness.

Module:5	**Wearable Computing**	**4 hours**

Factors in Wearable Technology, challenges, wearable Devices, Inputs, Applications, Algorithms, Classification of Wearable Devices based on Function and Creation.

Module:6	**Affective Computing**	**5 hours**

Definitions, Use cases, emotions descriptions, affective data model, affective computing terminologies, Affective Tools.

Module:7	**The Web of Things (WOT)**	**4 hours**
WoT, Basic Ideas, Communication Stack, WoT Architecture: Proxy-in, Proxy-out, Device Management, Data Processing, End User Service Creation, Use Case: Smart Home, Cross Domain.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Minyi Guo, Jingyu Zhou, Feilong Tang, Yao Shen ,"Pervasive Computing: Concepts, Technologies and Applications",CRC Press, 2016.
Reference Books	
1.	Stefan Posland, Ubiquitous Computing: Smart Devices, Environments And Interactions, Wiley Edition, 2011.
2.	Richard Ferraro, Murat Aktihanoglu, Location-Aware Applications, Manning Publications, 1st edition, 2011.
3.	Obaidat, Mohammad S., Mieso Denko, and Isaac Woungang, eds. Pervasive computing and networking. John Wiley & Sons, 2011.
4.	Laurence T. Yang, Handbook On Mobile And Ubiquitous Computing Status And Perspective, 2012, CRC Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI3033	Web Mining and Social Network Analysis	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**Nil**	**Syllabus Version**				
		1.0				

Course Objectives:

1. Apply machine learning concepts to web content mining.
2. Design an ontology and Implement Page Ranking algorithm and modify the algorithm for mining information.
3. Analyze social media data using appropriate data/web mining techniques.

Course Outcome:

1. To gain knowledge about the basics of web mining, social network analysis.
2. To focus on a detailed overview of the Machine learning algorithms and techniques, specifically, those that are relevant to Web mining and social network analysis.
3. To learn knowledge representation using ontology.
4. Develop the semantic web approaches for web content mining.
5. Appreciate various aspects of web link and usage mining.
6. Detecting and analyzing the communities in web social networks.

Module:1	**Introduction**	**6 hours**

Introduction-Web Mining-Theoretical background -Information retrieval and Web search – Information retrieval Models-Relevance Feedback- Text and Web page Pre-processing - Introduction -Social Networks Analysis- Co-Citation and Bibliographic Coupling.

Module:2	**Structure Mining**	**4 hours**

Web Crawling -A Basic Crawler Algorithm- Implementation Issues- Universal Crawlers- Focused Crawlers- Topical Crawlers Evaluation - Crawler Ethics and Conflicts - New Developments. Web Search and Hyperlink- Co-citation and Bibliographic Coupling- PageRank and HITS Algorithms- Web Community Discovery.

Module:3	**Web Content Mining**	**6 hours**

Web Content Mining – Supervised Learning – Decision tree - Naïve Bayesian Text Classification - Support Vector Machines - Ensemble of Classifiers. Unsupervised Learning - K-means Clustering - Hierarchical Clustering –Partially Supervised Learning – Markov Models - Probability-Based Clustering - Evaluating Classification and Clustering – Vector Space Model – Latent semantic Indexing.

Module:4	**Web Usage Mining**	**4 hours**

Data Collection and Pre-Processing- Data Modeling for Web Usage Mining- Discovery and Analysis of Web Usage Patterns- Recommender Systems and Collaborative Filtering- Query Log Mining

Module:5	**Social Network Analysis**	**9 hours**

Page Rank -Authorities and Hubs -Link-Based Similarity Search - Enhanced Techniques for Page Ranking - Community Discovery. Network Fundamentals-underlying assumptions-Entities and relations-network-Research design elements-Basic method for Analyzing the networks- Graphs and matrices - Dyadic network triadic network - cliques - groups-clustering search-Advanced method for analyzing network-Ego nets, two mode, three mode networks-Visualizations.

Module:6	**Sentiment Analysis**	**7 hours**

Introduction-Sentiment Analysis- Sentiment Analysis Applications- Sentiment Analysis Research- Sentiment Analysis as Mini NLP- Supervised Sentiment Classification-Unsupervised Sentiment Classification- Sentiment Rating Prediction- Sentence Subjectivity and Sentiment Classification- Aspect Sentiment Classification-Challenges of sentiment analysis in social network analysis.

Module:7	**Opinion Mining**	**7 hours**

Definition of Opinion-Affect, Emotion, and Mood-Different Types of Opinions-Analysis of Comparative Opinions-Problem Definition-Identify Comparative Sentences-Identifying the Preferred Entity Set-Special Types of Comparison-Entity and Aspect Extraction-Opinion Summarization and Search- Enhancements to Aspect-Based Summary - Contrastive View Summarization - Traditional Summarization -Summarization of Comparative Opinions - Opinion Search -Existing Opinion Retrieval Techniques.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)	
1	Bing Liu, " Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data-Centric Systems and Applications)", Springer; 2nd Edition 2019
2	Bing Liu, "Sentiment Analysis: mining sentiments, opinions, and emotions", Cambridge University Press, 2nd edition, 2020.
Reference Books	
1.	Stephen P Borgatti, Martin G Everett, Jeffrey C Johnson "Analyzing Social Networks", SAGE Publications 2018.
2.	David Knoke & Song Yang, "Social Network Analysis", Sage Publishing, Third Edition, 2020.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of evaluation: Project/Activity

Project Component:

This course aims to equip students with the skills to perform and interpret web mining and Social network analysis. The prescribed hands-on projects will help the students to understand the fundamentals of web mining and social network analysis inference by examining some simple ontology models. Students will develop the skill of web mining and social network analysis with ontology framework through machine learning algorithms and techniques. More advanced models will then be explored by the students through these projects, including machine learning predictive models in an ontology framework. Social network analysis, especially web service methods will progressively be introduced as practical hands-on programming .Special emphasis will be given on how students choose evaluation metrics and how they evaluate those prescribed models influenced by ontology and social network analysis framework.

Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI4001	Natural Language Processing and Computational Linguistics	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To familiarize the concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS.
2. To relate mathematical foundations, Probability theory with Linguistic essentials such as syntactic and semantic analysis of text.
3. To apply the Linguistic methods and cutting-edge research models from deep learning.

Course Outcome:

1. Apply the principles and Process of Human Languages such as English and other Indian Languages using computers.
2. Realize semantics and pragmatics of English language for text processing
3. Create CORPUS linguistics based on digestive approach (Text Corpus method)
4. Check a current methods for statistical approaches to machine translation.
5. Perform POS tagging for a given natural language and Select a suitable language modelling technique based on the structure of the language.
6. Demonstrate the state-of-the-art algorithms and techniques for text-based processing of natural language with respect to morphology.
7. Develop a Statistical Methods for Real World Applications and explore deep learning based NLP.

Module:1	**Overview of NLP**	**4 hours**

Introduction and Basic Text Processing – What we do in NLP, Why NLP is hard, empirical laws and text processing, Ambiguity and uncertainty in language, The Turing test. Introduction to NLTK (Natural Language Tool Kit)

Module:2	**Text Processing**	**6 hours**

Introduction to Corpora, Corpora Analysis, word and sentence segmentation, edit distance-weighted edit distance, dynamic programming edit distance, spelling correction – non-word spelling errors, real world spelling errors, noisy channel model - introduction, real-world spell correction.

Module:3	**N-Gram Language models**	**8 hours**

Introduction - Probabilistic language model and its application (speech recognition, machine translation, completion prediction), Probabilistic language modeling – chain rule – markov assumption, N-Gram model – computing unigram, bigram, trigram probabilities, Evaluation of language models (extrinsic and intrinsic), smoothing – Laplace smoothing, Add-k smoothing.

Module:4	**Morphology and Context free grammar**	**7 hours**

Morphology – Allomorphs, bound & free morphemes, stems and affixes, types of affixes, content and functional morphemes, Inflectional and derivational morphology, morphology processing, finite state automaton(FSA), morphological analysis – Linguistic and engineering approach, Constituency, CFG definition - use and limitations. Chomsky Normal Form. Top-down parsing, bottom-up parsing.

Module:5	**Part of speech tagging**	**7 hours**

The concept of parts-of-speech, examples, usage. The Penn Treebank and Brown Corpus, Generative vs conditional models, Hidden Markov Models for POS Tagging, Viterbi Algorithm, maximum entropy model, conditional random fields (CRF).

Module:6	**Lexical Semantics**	**6 hours**

Introduction to lexical semantics (Homonymy, polysemy, synonymy, antonymy, hypernymy,

hyponymy, meronymy) , wordnet – synsets, lemma vs synsets, word similarity – Thesaurus based word similarity, path-based similarity, concept probability models, information content , resnik similarity, lin similarity, jiang-conrath similarity , word sense disambiguation – random walk algorithm.		
Module:7	**Application of NLP**	**5 hours**
Machine Translation - Comparing Machine Translation and Human Translation: A Case Study, Information Extraction - Extracting Information from Structured Normal Documents: A Case Study, Text Summarization - Text Classification using Text Summarization– A case study, Sentiment Analysis - Case Study : Sentiment analysis using Python.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s) and Journals

1.	Mohamed Zakaria Kurdi, "Natural Language Processing and Computational Linguistics: Speech, Morphology and Syntax", First Edition, Wiley,. Hobson lane, Cole Howard, 2016.

Reference Books

1.	Daniel Jurafsky and James H. Martin "Speech and Language Processing", 3rd edition, Prentice Hall, 2009.
2.	NitinIndurkhya, Fred J. Damerau "Handbook of Natural Language Processing", Second Edition, CRC Press, 2010.
3.	Hannes Hapke, "Natural language processing in action" MANNING Publications, 2019.
4.	Alexander Clark, Chris Fox, Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", Wiley-Blackwell, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Sample J Component projects:

1. Sentiment Analysis:

Sentiment analysis (also known as opinion mining or emotion AI) is the use of natural language processing, text analysis, computational linguistics, and biometrics to systematically identify, extract, quantify, and study affective states and subjective information. Sentiment analysis is widely applied to voice of the customer materials such as reviews and survey responses, online and social media, and healthcare materials for applications that range from marketing to customer service to clinical medicine.

2. Chatbot:

Advancements in NLP have increased their usefulness to the point that live agents no longer need to be the first point of communication for some customers. Some features of Chatbot include being able to help users navigate support articles and knowledge bases, order products or services, and manage accounts.

Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI4002	Logic and Combinatorics for Computer Science	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus Version**				
		1.0				

Course Objectives

1. To impart foundations of logic and combinatorics.
2. To apply concepts of logic in computational problems.
3. To assess the importance of various combinatorial notions in computer science domain.
4. To comprehend the necessity of logic, relations and functions in AI/DBMS/Data mining.

Course Outcomes

1. Understanding the fundamentals of logic.
2. Articulating normal forms and inference rules for theorem proving.
3. Applying the concepts predicate calculus and quantifiers for deducing rules and proofs.
4. Developing a mathematical maturity by introducing combinatorial principles and extend them to probabilistic combinatorics.
5. Articulating algebraic combinatorics and basics of enumeration and counting.
6. Understanding basics of set theory, relations and functions.
7. Appreciating the utilities of logic and combinatorics in real-world computer science.

Module:1	**Fundamentals of Logic**	**6 Hours**

Statements and notations, Logical connectives- negation, conjunction, disjunction- conditional and biconditional- Statement formulas, Truth tables, Well-formed formulas, Tautologies and contradictions, Equivalence, Duality law, Tautological implications, More connectives, Two-state devices and statement logic.

Module:2	**Advanced Logic**	**4 Hours**

Normal forms, DNF, CNF, PDNF, PCNF, Ordering and uniqueness of normal forms, Theory of inference for statement calculus, Validity using truth tables.

Module:3	**Proofs of theorems**	**5 Hours**

Rules of inference, Consistency of premises and indirect method of proof, Automatic theorem proving, Use of universal and existential quantifiers in proofs of theorems.

Module:4	**Predicate Calculus**	**8 Hours**

Predicates, Statement functions, variables, quantifiers, Predicate formulas, free and bound variables, Universe of discourse, Inference theory, Valid formulas and equivalences, Valid formulas over finite universe, Valid formulas involving quantifies, Inference theory for predicate calculus, Formulas with more than one quantifier.

Module:5	**Fundamentals of Combinatorics**	**6 Hours**

Fundamental principles of counting, Rules of sum and product, Permutations, Combinations, Binomial theorem, Combinations with repetition, Basics of Discrete probability, Pigeonhole principle.

Module:6	**Enumeration and Counting**	**7 Hours**

Principles of inclusion and exclusion, Generalization, Derangements, Rook polynomials, Arrangements with forbidden positions, Generalized Permutations and Combinations, Generating Permutations and Combinations.

Module:7	**Advanced Counting Techniques**	**7 Hours**

Number sequences, Generating Functions, Exponential Generating Function, Solving Linear Homogeneous Recurrence Relations, Nonhomogeneous Recurrence Relations, Special counting sequences- Catalan numbers and Stirling numbers.

Module:8	**Contemporary Issues**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)

1. Tremblay J. P, Manohar R., Discrete Mathematical Structures with Applications in Computer Science, 1st Edition, McGraw Hill Education, 2017 (50%).
2. Grimaldi R.P., Ramana B.V., Discrete and Combinatorial Mathematics- An applied introduction, 5th Edition, Pearson Education, 2015 (50%).

Reference Book(s)

1. Brualdi R. A., Introductory Combinatorics, 5th Edition, Pearson Education, 2019.
2. Rosen K. H., Discrete Mathematics and its Applications, 7th Edition, Tata McGraw Hill, 2018.

Mode of Evaluation: CAT/Assignment/Quiz/Seminar/FAT

Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI4003	Computer Oriented Numerical Methods	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To develop the mathematical skills of the students in the areas of numerical methods.
2. To teach theory and applications of numerical methods in many engineering subjects which require solutions of linear systems, finding eigen values, eigenvectors, interpolation and applications, solving ODEs, PDEs and dealing with statistical problems like testing of hypotheses.
3. To lay foundation of computational mathematics for post-graduate courses, specialized studies and research.

Course Outcome:

1. Understand the use of numerical methods in modern scientific computing.
2. Understand with finite precision Computing.
3. Provide numerical solutions of nonlinear equations in a single variable
4. Apply numerical interpolation and approximation of functions
5. Apply numerical integration and differentiation
6. Provide numerical solution of ordinary differential equations
7. Be familiar with calculation and interpretation of errors in numerical methods.

Module:1	**Errors and Finite Differences**	**7 Hours**
Error & their analysis, Computer arithmetic, Floating-point number operation. Finite differences: Difference operator, Difference tables, Factorial polynomials, Summation of series.		
Module:2	**Algebraic & Transcendental Equations**	**6 Hours**
Bisection method, Iteration method, method of false position, Newton-Raphson method, Rate of convergence of methods.		
Module:3	**Interpolation**	**6 hours**
Newton's forward and backward interpolation, Gauss, Stirling's and Bessel's formula for equal interval, Lagrange's interpolation and Newton's divided difference formula for unequal interval.		
Module:4	**Solution to Simultaneous Linear Equations**	**6 hours**
Solution of simultaneous equations by Gauss elimination method, Gauss-Seidel's method, Jacobi's method.		
Module:5	**Solution of Ordinary Differential Equations**	**6 hours**
Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta method.		
Module:6	**Numerical Differentiation & Integration**	**8 hours**
Introduction, Numerical differentiation, Numerical integration by Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Boole's & Weddle's rule, Euler-Maclaurin's formula.		
Module:7	**Frequency distribution and Central Tendency**	**4 hours**
Central Tendency (Only Algorithm and its Application), Dispersion-Standard Deviation, Coefficient of Variance(Only Algorithm and its Application), Correlation and regression (All Methods and Examples with Algorithm and its Application).		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Rajaraman, Vaidyeswaran. Computer oriented numerical methods. PHI Learning Pvt. Ltd., 2018.

Reference Books

1. Sastry, S. S. (2012). Introductory methods of numerical analysis. PHI Learning Pvt. Ltd..

2.	Goyal, Manish. Computer based numerical & statistical techniques. Laxmi Publications, Ltd., 2008.
3.	Khandelwal, Anju. Computer Based Numerical & Statistical Techniques. New Age International, 2009.
4.	Pollard, John Hurlstone. A handbook of numerical and statistical techniques: with examples mainly from the life sciences. CUP Archive, 1979.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Implement Bisection, Newton Raphson, and False position methods.	4 Hours
2.	Solve the linear equations using Gaussian elimination method.	3 Hours
3.	Solve the linear equation using Gauss-Jordan method.	3 Hours
4.	Solve the differential equations using Taylor series method.	3 Hours
5.	Solve the differential equations using RK2 method.	3 Hours
6.	Solve the differential equations using RK4 method.	3 Hours
7.	Find solution for given integral function using Simpson's 1/3 rule	3 Hours
8.	Find solution for given integral function using Simpson's 3/8 rule	3 Hours
9.	Solve the linear equations using Jacobi's Method	3 Hours
10	Implement Lagrange's interpolation.	2 Hours
	Total Laboratory Hours	**30 Hours**

Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI4004	Text Mining	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To introduce the fundamental processes and major issues in text mining.
2. To offer adequate knowledge on extraction and summarization techniques.
3. To understand the clustering and classification techniques.
4. To explain the algorithms for text streams, anomaly and trend detection.
5. To impart the knowledge on various mining concepts and techniques that can be applied to multimedia and social media.
6. To appreciate the current trends in text mining.

Course Outcome:

1.Recognize key areas and issues in Information Extraction and Text Summarization.
2.Discover interesting patterns using Clustering and Classification techniques.
3.Formulate patterns using Text streams, Anomaly and trend detection.
4.Apply text mining to multimedia and social media application.
5.Summarize about the recent trends in text mining.
6.Solve the test cases and implement text mining concepts in real time applications.

Module:1	**Information Extraction and Text Summarization**	**7 hours**

Information Extraction - Named Entity Recognition - Relation Extraction - Unsupervised Information Extraction; Text Summarization - Topic Representation Approaches - Indicator Representations and Machine Learning.

Module:2	**Clustering**	**8 hours**

Feature Selection and transformation Methods - Distance-based Clustering Algorithms - Word and Phrase based Clustering - Probabilistic Document Clustering and Topic Models - Online Clustering with Text Streams; Multilingual document clustering - Multilingual LSA, LSA with term alignments, LMSA with term alignments.

Module:3	**Classification**	**7 hours**

Feature Selection for Text Classification, Probabilistic and Naive Bayes Classifiers, Proximity-based Classifiers, Classification of Linked and Web Data, Meta-Algorithms for Text Classification, Content-based spam email classification using machine-learning algorithms.

Module:4	**Anomaly and Trend Detection**	**6 hours**

Text Visualization techniques - Data Exploration and the search for novel patterns - Sentiment tracking - Visual analytics and FutureLens - Scenario discovery, Current research in Internet predation and cyberbullying.

Module:5	**Text Streams**	**7 hours**

Clustering and Classification of text streams, Feature extraction and data reduction - Event and trend descriptions, Embedding semantics in LDA topic models - embedding external semantics from Wikipedia - data driven semantic embedding.

Module:6	**Text Mining in Multimedia**	**4 hours**

Surrounding Text Mining, Joint Text and Visual Content Mining, Cross Text and Visual Content Mining.

Module:7	**Text Analytics in Social Media**	**4 hours**

Applying Text Analytics to Social Media, Opinion Mining and Sentiment Analysis, Text Mining Applications and Case studies.

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**

Text Book(s)

1. Charu C. Aggarwal ,ChengXiang Zhai, “Mining Text Data”, 2012, First Edition,

	Springer Science & Business Media, Berlin, Germany (Module 1 to 3, Module 5 to 7)
2.	Dipanjan Sarkar, "Text Analytics with Python", 2019, Second Edition, Apress Publisher, New York, USA.
Reference Books	
1.	Gary Miner, John Elder, Andrew Fast, Thomas Hill, Robert Nisbet, Dursun Delen, "Practical text mining and statistical analysis for non-structured text data applications", 2012, First Edition, Academic Press, USA.
2.	Michael W. Berry, Jacob Kogan ,"Text Mining Applications and Theory", 2010, First Edition, Wiley publications, New Jersey, USA (Module 4).
3.	Julia Silge, Davis Robinsom, "Text Mining with R", 2017, First Edition, O'REILLY, USA.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI4005	Augmented Reality and Virtual Reality	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To introduce the augmented reality concepts, techniques and models.
2. To introduce the virtual reality concepts, techniques and models.
3. To develop augmented reality and virtual reality models.

Course Outcome:

1. Understand the fundamental of AR, VR and Mixed Reality and to design a customized solution.
2. Familiarize on the concepts, techniques and reporting methods of AR and VR.
3. Explore the methods used to Visualization, Interaction and Modelling in AR and VR.
4. Explore the techniques, technologies and approaches needed for developing AR applications.
5. Familiarize the techniques, technologies and approaches needed for developing VR applications.
6. Developing architecture, simulation, exploration of various AR, VR and Mixed Reality Applications.

Module:1	**Introduction to basic concepts of AR and VR**	**3 hours**

Introducing importance and applications of Augmented and Virtual Reality Systems. History and differences between Augmented and Virtual Reality. Basics of Computer Vision and Multimodal Interaction. Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality.

Module:2	**Augmented Reality Concepts**	**4 hours**

Displays – Taxonomy, technology and features of augmented reality, Challenges with AR, AR systems and functionality- Major software and hardware components for AR – Software Architectures – Creating Augmented reality contents.

Module:3	**Principles and Practices**	**9 hours**

Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Module:4	**Introduction to Virtual Reality**	**8 hours**

Computer graphics, Real time computer graphics, Flight Simulation, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Color theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism Stereographic image

Module:5	**Interactive Techniques in Virtual Reality**	**7 hours**

Introduction to 2D and 3D concepts, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction to Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Module:6	**Visual Computation in Virtual Reality**	**6 hours**

Animating the Virtual Environment: The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & objects, free from deformation, particle system. Physical Simulation: Introduction to simulation concepts, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Module:7	**Applications of AR, VR and Mixed reality**	**6 hours**

Augmented Reality Applications – Future of AR - Present and Future state of VR – Convergence of AR and VR.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Deiter Schmaltieg, Tobbias Hollerrer, Augmented Reality, Principles and Practices. 2014, Adison Wesley - 40%.
2.	Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006 . 60%.
3	Tom Dieck, M. Claudia, Jung, Timothy, Correia Loureiro, Sandra Maria, Augmented Reality and Virtual Reality, New Trends in Immersive Technology. Springer publications. (Edited Book), 2021.
Reference Books	
1	Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
2	Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
3.	Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of evaluation: Project/Activity

Sample Project Topics:

- Developing architecture of a house using Virtual Reality.
- Perform CRO based experiment using Virtual Reality.
- Undertaking qualitative analysis in Chemistry using Virtual Reality.
- Carry out assembly/disassembly of an engine using Virtual Reality.
- Explore human anatomy using Virtual Reality.
- Simulation of circulation of blood in heart.
- Simulation of Fight/Vehicle/Space Station.
- Building Electronic circuit using Virtual Reality, given basic electronic components.
- Developing concept of Virtual class room with multiplayer.

Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI4006	Game Theory	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To learn the basic concepts of game theory.
2. To use game theory concepts to model economic phenomena.
3. To understand ideas such as dominance, backward induction and Nash equilibrium.

Course Outcome:

1. Demonstrate understanding of basic mathematical concepts in game theory
2. Identify theoretical structures for games and learn Nash equilibria in multiple game settings
3. Design and implement extensive games
4. Employ solutions to Bayesian games
5. Conceptualize problems on games with imperfect information
6. Demonstrate with illustrative examples strictly Competitive Games and repeated games.

Module:1	**Game theory**	**3 hours**

Introduction to Game theory, Rational choice, Attractions, Functions, Sequences, Probability

Module:2	**Strategic games, Nash Equilibrium: Theory and Applications**	**6 hours**

Strategic games, Examples: Prisoner's Dilemma, matching Pennies, the Stag Hunt. Nash equilibrium, Examples of Nash equilibrium, Best response functions, Dominated actions, Nash Equilibrium: Illustrations, Cournot's model of oligopoly, Bertrand's model of oligopoly, Electoral competition, War of Attrition, Auctions, Accident law.

Module:3	**Mixed Strategies & Mixed Strategy Equilibrium**	**6 hours**

Mixed strategy nash equilibrium, dominated actions, Pure equilibria when randomization is allowed, Illustration: expert diagnosis, Equilibrium in a single population, Illustration: reporting a crime, Players' beliefs, Extension: Finding all mixed strategy Nash equilibria, Extension: Mixed strategy Nash equilibria of games in which each player has a continuum of actions.

Module:4	**Extensive form Games**	**7 hours**

Extensive games with perfect information: Strategies and outcomes, Nash equilibrium, Subgame perfect equilibrium, Finding subgame perfect equilibria of finite horizon games: backward induction. Illustrations: Ultimatum game, the holdup game, and agenda control, Stackelberg's model of duopoly, Buying votes,
Extensions: Allowing for simultaneous moves, Illustration: entry into a monopolized industry, Discussion: subgame perfect equilibrium and backward induction.

Module:5	**Bayesian Games and Games with Imperfect Information**	**7 hours**

Bayesian Games: Motivational examples, General definitions, two examples concerning information, Cournot's duopoly game with imperfect information, providing a public good, auctions, juries. Games with Imperfect Information: Strategies, Nash equilibrium, Beliefs and sequential equilibrium, Signaling games, Illustration: conspicuous expenditure as a signal of quality, education as a signal of ability, strategic information transmission, agenda control with imperfect information.

Module:6	**Strictly Competitive Games**	**7 hours**

Strictly Competitive Games and Maxminimization, Maxminimization and Nash equilibrium, Rationalizability: Iterated elimination of strictly dominated actions, Iterated elimination of weakly dominated actions, Dominance solvability.

Module:7	**Repeated Games**	**7 hours**

Repeated games, Finitely repeated Prisoner's Dilemma, Infinitely repeated Prisoner's Dilemma,

Strategies in an infinitely repeated Prisoner's Dilemma, Some Nash equilibria of an infinitely repeated Prisoner's Dilemma, Nash equilibria of general infinitely repeated games, Subgame perfect equilibria of general infinitely repeated games, Finitely repeated games, Variation on a theme: imperfect observability.				
Module:8	**Contemporary Issues**			**2 hours**
	Total Lecture hours:			**45 hours**
Text Book(s)				
1	Martin J. Osborne, An introduction to game theory, International Edition, 2012,Oxford University Press, USA**.**			
2..	J.F. Nordstrom, Introduction to Game Theory: A Discovery Approach, Linfield University, 2020, McMinnville, Oregon.			
Reference Books				
1.	Thomas S Ferguson, Course in Game Theory, 2020, World Scientific Publishing Co., University of California, Los Angeles, USA.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
Mode of assessment:				
Recommended by Board of Studies		25-10-2021		
Approved by Academic Council		No. 64	Date	16-12-2021

CSI4007	GPU Programming	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the basics of GPU architectures.
2. To write programs for massively parallel processors.
3. To understand the issues in mapping algorithms for GPUs and to introduce different GPU programming models.

Course Outcome:

1. Understand the basics of GPU programming.
2. Analyze the method of using memory and synchronization problem in GPUs.
3. Develop a parallel programs using CUDA.
4. Understand the error handling handling methodology.
5. Demonstrate different GPU algorithms.

Module:1	**GPU Programming**	**5 hours**
History, graphics processors, graphics processing units, GPGPUs - clock speeds, CPU / GPU comparisons, heterogeneity - accelerators, parallel programming, CUDA / OpenCL / OpenACC.		
Module:2	**GPU Computing**	**6 hours**
Evolution of GPU Architectures – Understanding Parallelism with GPU –Typical GPU Architecture – CUDA Hardware Overview – Threads, Blocks, Grids, Warps, Scheduling – Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.		
Module:3	**GPU Memory, Synchronization and streams**	**6 hours**
Memory hierarchy, DRAM / global, local / shared, private / local, textures, constant memory. Pointers, parameter passing, arrays and dynamic memory, multi-dimensional arrays. Memory consistency - Barriers (local versus global), atomics, memory fence. Synchronization across CPU and GPU. Asynchronous processing, tasks, task-dependence. Events, event-based-synchronization		
Module:4	**Cuda Programming**	**6 hours**
Using CUDA – Multi GPU – Multi GPU Solutions – Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.		
Module:5	**Error Handling**	**7 hours**
Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors.		
Module:6	**Algorithms on GPU**	**7 hours**
Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster.		
Module:7	**Developing GPU based Applications**	**6 hours**
Matrix multiplication - vector reduction - matrix multiplication with tiling and shared memory – graph traversal algorithms using GPU programming. Image processing. Graph algorithms. Simulations. Deep learning		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors – A Hands-on Approach", Third Edition, Morgan Kaufmann, 2016.

Reference Books				
1.	Shane Cook, CUDA Programming: ―A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012.			
2.	David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, ―Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.			
3.	Nicholas Wilt, "CUDA Handbook: A Comprehensive Guide to GPU Programming", Addison Wesley, 2013.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
Recommended by Board of Studies		25-10-2021		
Approved by Academic Council		No.64	Date	16-12-2021

CSI4008	Programming Paradigms	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**NIL**	**Syllabus version**				
		1.0				

Course Objectives:

1. To be able to express computational solutions in the main programming idioms.
2. To be able to select an appropriate programming language for solving a computational problem, with justification.
3. To know and understand the principles of functional and logic programming language.
4. Acquire tools to choose, use, evaluate and design programming languages.

Course Outcome:

1. Understanding the concepts of evolution of programming languages.
2. Analyzing the methods and tools to define syntax and semantics of a languages.
3. Understanding the Control Environments and the Procedures of different languages.
4. Interpreting the differences in the concepts of functional and logical programming languages.
5. Developing the insights about Parallel Programming concepts.

Module:1	**Design Principles of Programming Paradigms**	**5 hours**

Introduction- The Origins and Abstractions in Programming Languages - Computational Paradigms -Language Definition - Language Translation -Language Design Criteria: Efficiency, regularity, security and extensibility.

Module:2	**Syntax, Basic semantics and Data Types**	**8 hours**

Syntax: Lexical Structure of Programming Languages -Context-Free Grammars and BNFs - Parse Trees and Abstract Syntax Trees - EBNFs and Syntax Diagrams - Parsing Techniques and Tools- Basic Semantics: Semantic Functions- Declarations, Blocks, Scope and lifetime - The Symbol Table and its working mechanisms -Data Types and its mechanisms.

Module:3	**Abstract Data Types and formal Semantics**	**6 hours**

Abstract Data Types and Modules: The Algebraic Specification of Abstract Data Types- Abstract Data Type Mechanisms and Modules -Separate Compilation in C, C++ Namespaces, and Java Packages- Ada Packages -Modules in ML - Problems with Abstract Data Type Mechanisms

Formal Semantics: A Sample Small Language- Operational Semantics -Denotational Semantics- Axiomatic Semantics- Proofs of Program Correctness.

Module:4	**Control Expressions, Procedures and Environments**	**5 hours**

Control Expressions and Statements : Expressions - Conditional Statements and Guards, Exception Handling- Procedure Definition and Activation-Procedure Semantics- Parameter Passing Mechanisms- Procedure Environments, Activations, and Allocation-Dynamic Memory Management- Exception Handling and Environments.

Module:5	**Functional Programming**	**7 hours**

Functional Programming: Programs as Functions - Scheme: A Dialect of Lisp - ML: Functional Programming with static typing -Delayed Evaluation- Haskell- Overloading.

Module:6	**Logic Programming**	**6 hours**

Logic Programming: Logic and Logic Programs - Horn Clauses -Resolution and Unification. The Language Prolog - Problems with Logic Programming

Module:7	**Parallel Programming**	**6 hours**

Parallel Programming: Introduction to Parallel Processing- Parallel Processing and Programming Languages- Threads – Semaphores- Monitors –Message Passing- Parallelism in Non-imperative Languages

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Louden, Kenneth C., and Kenneth A. Lambert. Programming languages: principles and practices. Cengage Learning, Third Edition, 2012. (M1, M2, M3, M4, M5, M6, M7).	
Reference Books		
1.	Scott, Michael Lee. Programming language pragmatics. Morgan Kaufmann, Fourth Edition, 2015. (M1, M2, M4, M6, M5).	
2	Friedman, Daniel P., Mitchell Wand, and Christopher Thomas Haynes. Essentials of programming languages. MIT press, Third Edition, 2008 (M3, M4, M2).	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1	Experiments on exploring language definitions, features, design and processing of programming languages	4 hours
2	Experiments to understand semantics and syntax analyzer through programming languages	4 hours
3	Experiments on abstract data types in programing languages	4 hours
4	Experiments on exceptions, parameter passing, runtime environments, expressions and control statements in programming languages	4 hours
5	Experiments on functional programming concepts of programming languages	5 hours
6	Experiments on logic programming concepts of programming languages	5 hours
7	Experiments on Parallel programming features in programming languages	4 hours
	Total Laboratory Hours	30 hours
Mode of assessment: CAT/Assignments/FAT		
Recommended by Board of Studies	25-10-2021	
Approved by Academic Council	No. 64 Date 16-12-2021	

CSI4009	Mathematical Modeling and Simulation	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the concept of modeling and dynamic systems.
2. To process the mathematical model and choose a best model.
3. To comprehend the concepts of Simulating Deterministic and Probabilistic Behavior.
4. To recognize various simulation technique and validation technique.

Course Outcome:

1. Acquire the concept of dynamic systems and epidemic model.
2. Learn the concept of modeling, fitting the model to data.
3. Obtain the knowledge of Simulation modeling, Discrete modeling, Graph theory modeling, Decision theory modeling.
4. Implement the Monte-Carlo simulation and use various techniques for simulation.
5. Analyze the concepts of validating the technique.

Module:1	**Modeling Change**	**5 hours**
Modeling Concepts - Modeling Change with Difference Equations – Solution to Dynamical Systems – Systems of Difference equations – Discrete Epidemic Model.		
Module:2	**Modeling Process and Geometric Similarity**	**5 hours**
Mathematical Models – Modeling using Proportionality and Geometric Similarity.		
Module:3	**Model Fitting and experimental Modeling**	**6 hours**
Fitting models to Data graphically – Analytic methods of Fitting – Choosing a Best model – Experimental Modeling – Polynomial model – Cubic Spline model.		
Module:4	**Simulation Modeling and Discrete Probabilistic Modeling**	**8 hours**
Simulating Deterministic Behavior – Simulating Probabilistic Behavior – Probabilistic Modeling with Discrete Systems – Modeling component and System Reliability – Monte Carlo algorithms, random point generation, queuing models – Discrete-Event Simulation Model.		
Module:5	**Modeling using Graph Theory and Decision Theory**	**7 hours**
Describing Graphs – Graph Models – Connection to Programming – Probability and Expected value – Decision Trees - Sequential Decisions and Conditional Probabilities – Decisions Using Alternative Criteria.		
Module:6	**Simulation and Techniques**	**8 hours**
Barterning model, Monte-Carlo simulation, Approaches to differential equation: Heun method, Local stability theory: Bernoulli Trials, General techniques for simulating continuous random variables, simulation from Normal and Gamma distributions, simulation from discrete probability distributions, simulating a non – homogeneous Poisson Process and queuing system – MATLAB Simulink Demo.		
Module:7	**Validation Techniques**	**4 hours**
Goodness of Fit Tests - The Two-Sample Problem - Validating the Assumption of a Nonhomogeneous Poisson Process.		
Module:8	**Contemporary Issues**	**2 hours**
	Total hours:	**45 hours**

Text Book(s)

1. Frank R. Giordano; William P. Fox; Steven B. Horton, A First Course in Mathematical Modeling, International Edition 5, Cengage Learning EMEA publication, 2014.
2. S.M. Ross, Simulation, Fifth edition, Elsevier Publication, 2012.

Reference Books

1. J. N. Kapoor, Mathematical Modeling, Wiley Eastern Limited, 2015.

2.	A.M.Law and W.D.Kelton. Simulation Modeling and Analysis, T.M.H. Edition, 2014.		
3.	Velten K, Mathematical Modeling and Simulation: Introduction for Scientists and Engineers, 1st Edition, Wiley-VCH, Verlag, 2009.		
Mode of Evaluation: CAT/ Digital Assignments/Quiz/FAT			
Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

CSI4010	Cognitive Science and Decision Making	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives

1. To learn the basics of Cognitive Science with focus on acquisition, representation,
2. To apply the use of knowledge by individual minds, brains, and machines, as well as groups, institutions, and other Social entities.
3. To study the mind and intelligence, embracing psychology, artificial intelligence, neuroscience and linguistics.

Course Outcome

After successfully completing the course the student should be able to

1. Understand the Interdisciplinary Nature of Cognitive Science.
2. Explain the process of cognitive psychology and neuroscience.
3. Develop algorithms that use AI and machine learning along with human interaction and feedback.
4. Design suitable computational cognitive model.
5. Apply the cognitive models in real time applications.

Module:1	**Introduction to Cognitive Science**	**5 hours**

The Cognitive view –Some Fundamental Concepts – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science – Artificial Intelligence: Knowledge representation -The Nature of Artificial Intelligence - Knowledge Representation – Artificial Intelligence: Search, Control, and Learning.

Module:2	**Thinking And Cognitive Psychology**	**6 hours**

Thinking: The Relationship Between Thought And Language, Reasoning, Analyzing Arguments, Thinking as Hypothesis Testing, Likelihood and Uncertainty, Creative Thinking, Cognitive Psychology – The Architecture of the Mind - The Nature of Cognitive Psychology - Propositional Representation- Schematic Representation Cognitive Processes, Working Memory, and Attention.

Module:3	**Language Acquisition, Semantics and Processing Models**	**6 hours**

Language Acquisition: Milestones in Acquisition – Theoretical Perspectives- Semantics and Cognitive Science – Meaning and Entailment – Reference – Sense – Cognitive and Computational Models of Semantic Processing.

Module:4	**Decision Making**	**6 hours**

Reasoning – Decision Making – Computer Science and AI: Foundations & Robotics – New Horizons - Dynamical systems and situated cognition- Challenges – Emotions and Consciousness – Physical and Social Environments - Information Processing Models of the Mind- Neural networks and distributed information processing- Neural network models of Cognitive Processes.

Module:5	**Computational Cognitive Modeling**	**7 hours**

Connectionist models of cognition, dynamical systems approach to cognition. Cognitive Models of memory and language, computational models of episodic and semantic memory, modeling psycholinguistics, Cognitive Modeling: modeling the interaction of language, memory and learning.

Module:6	**Classical Models**	**7 hours**

Bayesian Inference and Hierarchical Bayesian Models - Frameworks for Knowledge Representation: First-order Logic, Formal Grammars, Associative Networks, Taxonomic Hierarchies, Relational Schemas Modeling select aspects of cognition classical models of rationality, symbolic reasoning and decision making, Formal models of inductive generalization, causality, categorization and similarity.

Module:7	**Cognition And Artificial Intelligence**	**6 hours**

Modeling aspects of human cognition on Artificial Intelligence; cognitive architectures such

as ACT-R, SOAR, OpenCog, CopyCat, Memory Networks; Unstructured Information Management Architecture (UIMA), Structured Knowledge, Business Implications, Building Cognitive Applications, Application of Cognitive Computing and Systems, Quantum Models of Cognition, Models of Emergence.			
Module:8	**Contemporary Issues**		**2 hours**
	Total Lecture hours:		**45 hours**
Text Book(s)			
1.	Cognitive Science: An Introduction to the Science of the Mind , José Luis Bermúdez, Cambridge University Press, New York, Third Edition, 2020.		
2.	Cognitive Psychology, Robert L. Solso, Otto H. MacLin and M. Kimberly MacLin, 8th Edition, , Pearson Education, 2017.		
Reference Books			
1.	Artificial Intelligence: A Modern Approach. Russell, Stuart J., and Peter Norvig. Prentice Hall/Pearson Education, 3rd Edition, 2015.		
2.	Cognitive Science: An Interdisciplinary Approach, Carolyn Panzer Sobel and Paul Li, 2nd Edition, 2013.		
3.	Halpern, D. F. Thought and knowledge: An introduction to critical thinking, 5th Edition, Mahwah, NJ: Erlbaum, 2003.		
4.	Kahneman, D. Thinking, fast and slow. New York, NY: Farrar, Straus & Giroux, 2011		
Mode of Evaluation: CAT 1, CAT 2 & FAT			
Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No.64	Date	16-12-2021

MAT2002	Applications of Differential and Difference Equations	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**MAT1011 - Calculus for Engineers**	**Syllabus Version**				
		1.0				

Course Objectives

The course is aimed at

[1] Presenting the elementary notions of Fourier series, which is vital in practical harmonic analysis

[2] Imparting the knowledge of eigenvalues and eigen vectors of matrices and the transform techniques to solve linear systems, that arise in sciences and engineering [3] Enriching the skills in solving initial and boundary value problems

[4] Impart the knowledge and application of difference equations and the Z-transform in discrete systems, that are inherent in natural and physical processes

Course Outcome

At the end of the course the student should be able to

[1] Employ the tools of Fourier series to find harmonics of periodic functions from the tabulated values

[2] Apply the concepts of eigenvalues, eigen vectors and diagonalisation in linear systems

[3] Know the techniques of solving differential equations

[4] understand the series solution of differential equations and finding eigen values, eigen functions of Strum-Liouville's problem

[5] Know the Z-transform and its application in population dynamics and digital signal processing

[6]demonstrate MATLAB programming for engineering problems

Student Learning Outcomes (SLO):	**1, 2, 9**	
Module:1	**Fourier series:**	**6 hours**

Fourier series - Euler's formulae - Dirichlet's conditions - Change of interval - Half range series – RMS value – Parseval's identity – Computation of harmonics

Module:2	**Matrices:**	**6 hours**

Eigenvalues and Eigen vectors - Properties of eigenvalues and eigen vectors – Cayley-Hamilton theorem - Similarity of transformation - Orthogonal transformation and nature of quadratic form

Module:3	**Solution of ordinary differential equations**:	**6 hours**

Linear second order ordinary differential equation with constant coefficients – Solutions of homogenous and non-homogenous equations - Method of undetermined coefficients – method of variation of parameters – Solutions ofCauchy-Euler and Cauchy-Legendre differential equations

Module:4	**Solution of differential equations through Laplace transform and matrix method**	**8 hours**

Solution of ODE's - Nonhomogeneous terms involving Heaviside function, Impulse

function - Solving nonhomogeneous system using Laplace transform – Reduction of *n*th order differential equation to first order system - Solving nonhomogeneous system of first order differential equations  and 		
Module:5	**Strum Liouville's problems and power series Solutions:**	**6 hours**
The Strum-Liouville's Problem - Orthogonality of Eigen functions - Series solutions of differential equations about ordinary and regular singular points - Legendre differential equation - Bessel's differential equation		
Module:6	**Z-Transform:**	**6 hours**
Z-transform -transforms of standard functions - Inverse Z-transform: by partial fractions and convolution method		
Module:7	**Difference equations:**	**5 hours**
Difference equation - First and second order difference equations with constant coefficients - Fibonacci sequence - Solution of difference equations - Complementary function - Particular integral by the method of undetermined coefficients - Solution of simple difference equations using Z-transform		
Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, John Wiley India, 2015	
Reference Books		
1.	Higher Engineering Mathematics, B. S. Grewal, 43rd Edition, Khanna Publishers, India, 2015	
2.	Advanced Engineering Mathematics by Michael D. Greenberg, 2nd Edition, Pearson Education, Indian edition, 2006	
Mode of Evaluation		
Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test		
1.	Solving Homogeneous differential equations arising in engineering problems	2 hours
2.	Solving non-homogeneous differential equations and Cauchy, Legendre equations	2 hours
3.	Applying the technique of Laplace transform to solve differential equations	2 hours
4.	Applications of Second order differential equations to Mass spring system (damped, undamped, Forced oscillations), LCR circuits etc.	2 hours
5.	Visualizing Eigen value and Eigen vectors	2 hours
6.	Solving system of differential equations arising in engineering	2 hours

	applications	
7.	Applying the Power series method to solve differential equations arising in engineering applications	3 hours
8.	Applying the Frobenius method to solve differential equations arising in engineering applications	3 hours
9.	Visualising Bessel and Legendre polynomials	3 hours
10.	Evaluating Fourier series-Harmonic series	3 hours
11.	Applying Z-Transforms to functions encountered in engineering	3 hours
12.	Solving Difference equations arising in engineering applications	3 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies			
Approved by Academic Council	No. 37	Date	16-06-2015

MDI3002	Foundations of Data Science	L	T	P	J	C
		3	0	0	0	3

Pre-requisite	NIL	Syllabus version
		1.0

Course Objectives:

1. To provide fundamental knowledge on data science and to understand the role of statistics and optimization to perform mathematical operation in the field of data science.
2. To understand the process of handling heterogeneous data and visualize them for better understanding.
3. To gain the fundamental knowledge on various open source data science tools and understand their process of applications to solve various industrial problems.

Course Outcome:

1. Ability to obtain fundamental knowledge on data science.
2. Demonstrate proficiency in statistical analysis of data.
3. Develop mathematical knowledge and study various optimization techniques to perform data science operations.
4. Handle various types of data and visualize them using through programming for knowledge representation.
5. Demonstrate numerous open source data science tools to solve real-world problems through industrial case studies.

Student Learning Outcomes (SLO):	1,5,14

Module:1	Basics of Data Science	5 hours

Introduction; Typology of problems; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems, Structured and unstructured data

Module:2	Statistical Foundations	7 hours

Descriptive statistics, Statistical Features, summarizing the data, outlier analysis, Understanding distributions and plots, Univariate statistical plots and usage, Bivariate and multivariate statistics, Dimensionality Reduction, Over and Under Sampling, Bayesian Statistics, Statistical Modeling for data analysis

Module:3	Algorithmic Foundations	8 hours

Linear algebra Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Matrix factorizations; Inner products; Distance measures; Projections; Notion of hyperplanes; half-planes, elementary spectral graph theory. Sampling and VC-dimension - Random walks and graph sampling, MCMC algorithms, learning, linear and non-linear separators, PAC learning

Module:4	Optimization	7 hours

Unconstrained optimization; Necessary and sufficiency conditions for optima; Gradient descent methods; Constrained optimization, KKT conditions; Introduction to non-gradient techniques; Introduction to least squares optimization

Module:5	Programming Foundation and Exploratory Data Analysis	6 hours

Introduction to Python Programming, Types, Expressions and Variables, String Operations, selection, iteration, Data Structures- Strings, Regular Expression, List and Tuples, Dictionaries, Sets; Exploratory Data Analysis (EDA) - Definition, Motivation, Steps in data exploration, The basic datatypes, Data type Portability, Basic Tools of EDA, Data Analytics Life cycle, Discovery

Module:6	Data Handling and Visualization	6 hours

Data Acquisition, Data Pre-processing and Preparation, Data Quality and Transformation,

Handling Text Data; Introduction to data visualization, Visualization workflow: describing data visualization workflow, Visualization Periodic Table; Data Abstraction -Analysis: Four Levels for Validation- Task Abstraction - Analysis: Four Levels for Validation Data Representation: chart types: categorical, hierarchical, relational, temporal & spatial			
Module:7	**Data Science Tools and Techniques**		**4 hours**
Overview and Demonstration of Open source tools such as R, Octave, Scilab. Python libraries: SciPy and sci-kitLearn, PyBrain, Pylearn2; Weka.			
Module:8	**Recent Trends**		**2 hours**
Total Lecture hours			**45 hours**
Text Books			
1.	R. V. Hogg, J. W. McKean and A. Craig, Introduction to Mathematical Statistics, 8th Ed., Pearson Education India, 2019.		
2.	Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science", Cambridge University Press, 2020.		
Reference Books			
1	Ani Adhikari and John DeNero, 'Computational and Inferential Thinking: The Foundations of Data Science' , GitBook, 2019.		
2	Cathy O'Neil and Rachel Schutt, 'Doing Data Science: Straight Talk from the Frontline', O'Reilly Media, 2013.		
3.	Hossein Pishro-Nik, "Introduction to Probability, Statistics, and Random Processes", Kappa Research, LLC, 2014.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	11-02-2021		
Approved by Academic Council	No. 61	Date	18-02-2021

MDI3003	Advanced Predictive Analytics	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To learn, how to develop models to predict categorical and continuous outcomes, using techniques such as decision trees, logistic regression, neural networks, and Bayesian models.
2. To advice on when and how to use each model. Also learn how to combine two or more models to improve prediction.

Course Outcome:

1. Understand the process of formulating objectives, data selection/collection, preparation and process to successfully design the model.
2. Able to prepare and process data for the models.
3. Gain the insights from the data through Exploratory Data Analysis for feature engineering.
4. Compare the underlying predictive modeling techniques. Analyze on the performance of the model and the quality of the results.
5. Explore Hybrid models to enhance the prediction performance.
6. Compare time series models and apply predictive modeling approaches using a suitable python package.

Module:1	**Introduction**	**4 hours**
Overview of Predictive Analytics – Business Intelligence - Statistics – Challenges – Data , Modelling Obstacles – Processing Steps: CRISP-DM.		
Module:2	Problem Understanding and Data Preparation	**6 hours**
Understanding Business problem – Prediction Variable – Data Requirement – Access to Data – Solution Method – Key Metrics - Model Performance - Diamond prices – Case Study - Data Collection - Preparation - Numerical features - Encoding Categorical Features - Low Variance Features - Near Collinearity One-hot Encoding.		
Module:3	**Feature Engineering**	**6 hours**
Dataset Understanding - Exploratory Data Analysis - Univariate – Bivariate – Multivariate – Encoding Categorical Predictors – Engineering Numeric Predictors – Feature Selection – Methodologies – Irrelevant Feature Effect – Overfitting – Greedy Search – Global Search.		
Module:4	**Predictive Modeling**	**7 hours**
Decision Trees – Logistic Regression – Neural Networks – k-NN – Naïve Bayes – Linear Regression.		
Module:5	**Model Assessment and Ensembles**	**7 hours**
Approaches - Batch Assessment – Rank-Ordered – Assessing Regression Models – Model Ensembles – Bagging – Boosting – Random Forests – Heterogeneous Ensembles.		
Module:6	**Time Series Prediction**	**7 hours**
Statistical Models – Autoregressive Models – Moving Average Models – Autoregressive Integrated Moving Average Models – Statespace Models – Hidden Markov Models – Deep Learning Models – Recurrent Neural Networks.		
Module:7	**Python Stack and Case Studies**	**6 hours**
Anaconda – Jupyter – NumPy - pandas - Matplotlib – Seaborn - Scikit-learn - TensorFlow – Keras – Dash – Case Studies – Diamond Prices – Credit Card Defaults.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)				
1.	Feature Engineering and Selection: A Practical Approach for Predictive Models – 1st edition, *Max Kuhn and Kjell Johnson, 2019, Taylor and Francis.*			
Reference Books				
1.	Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst – 1st edition, Dean Abbott, Wiley, 2014			
2.	Hands-On Predictive Analytics with Python: Master the Complete Predictive Analytics Process, from Problem Definition to Model Deployment -1st edition, Alvaro Fuentes, Birmingham: Packet Publishing, 2018.			
3.	Practical Time Series Analysis, Aileen Nielsen - 1st edition, 2019, O'Reilly Media.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Experiments				
1.	House rent prediction using linear regression			3 hours
2.	Medical diagnosis for disease classification using decision trees			3 hours
3.	Automate email classification and response using k-NN classifiers			2 hours
4.	Customer segmentation in business model based on their demographic, psychographic and behavior data using Naïve Bayes Classifiers			3 hours
5.	Analysis of tweet data to predict the sentiments on a product			2 hours
6.	Analyze crime data using AR and ARIMA time series techniques on reported incidents of crime based on time and location			2 hours
7.	Construct a recommendation system based on the customer transaction data using Random Forest method			2 hours
8.	Prediction on power consumption data to suggest for minimizing the usage			2 hours
9.	Buying prediction of customers for any online product purchase			3 hours
10	Agricultural data analysis for yield prediction and crop selection on Indian terrain data set			3 hours
11.	Develop a recommender system for any real-world problem (when a user queries to find the good hospital for Covid-19 treatment)			3 hours
12.	Develop a business model to predict the trend in Investment and Funding			2 hours
			Total Laboratory Hours	**30 hours**
Mode of Evaluation: Project/Activity				
Recommended by Board of Studies	25-10-2021			
Approved by Academic Council	No. 64	Date	25-11-2021	

MDI3007	Fault Tolerant Computing System	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the fault tolerant design principles.
2. To identify the requirement of fault tolerant systems.
3. To understand fault tolerant distributed systems and its requirement.
4. To design algorithms for fault tolerant systems.

Course Outcomes::

After successfully completing the course, the students should be able to

1. Understand the risk of failures and their peculiarities with different system failures.
2. Be aware of the threat from software defects and human operator error as well as from hardware failures.
3. Know the different advantages and limits of fault avoidance and fault tolerance design techniques.
4. Understand the different types of fault avoidance and fault tolerance in network.
5. Be able to specify the use of fault tolerance in the design of application software and the hardware.
6. Be able to specify the use of fault tolerance in the Cryptographic Systems.
7. Understand the relevant factors in evaluating alternative system designs for a specific set of requirements in network.

Module:1	**Fault tolerance and Redundancy**	**3 hours**

Error, Faults and Failures; Reliability and Availability; Classification of Fault, Basic Measures of Fault Tolerance, Redundancy.

Module:2	**Fault tolerant strategies**	**6 hours**

Fault detection, masking, containment, location, reconfiguration, and recovery.

Module:3	**Fault tolerant design techniques**	**7 hours**

Hardware redundancy, software redundancy, time redundancy, and information redundancy.

Module:4	**Fault-Tolerant Networks**	**7 hours**

Network Topologies and their Resilience; Fault-tolerant Routing.

Module:5	**Hardware and Software Fault tolerance**	

Canonical and Resilient Structures; Reliability Evaluation Techniques and Models; Processor- level Fault Tolerance; Byzantine Failures and Agreements. Single-Version Fault Tolerance; N-Version Programming; Recovery Approach; Exception and Conditional (Assert) Handling; Reliability Metrics and Models.

Module:6	**Fault Detection in Cryptographic Systems**	**7 hours**

Cipher, Fault Injection, Security Attacks Through Fault Injection, protection against fault injection–based attacks- Spatial and Temporal Duplication, Error-Detecting Codes.

Module:7	**Fault Handling: Industry 4.0 and Cyber Physical Production Systems (CPPS)**	**5 hours**

Fault handling in industrial automated production systems (aPS), Development of Runtime Environments and their Domain Specific Challenges of Programming Languages for aPS.

Module:8	**Contemporary Issues**	**2 hours**

Total Lecture hours:	**45 hours**

Text Book(s)

1. Israel Koren and C. Mani Krishna; Fault-Tolerant Systems, 2nd Edition ; Morgan-Kaufman Publishers, 2020 (Module 1, 2, 3, 4, 5, 6).
2. Vogel-Heuser, Birgit, Susanne Rösch, Juliane Fischer, Thomas Simon, Sebastian

	Ulewicz, and Jens Folmer. "Fault handling in PLC-based industry 4.0 automated production systems as a basis for restart and self-configuration and its evaluation." Journal of software engineering and applications, Vol. 9, no. 01, 2016.(Module 7).
Reference Books	
1.	Michael R. Lyu; Handbook of Software Reliability Engineering; IEEE Computer Society Press (and McGraw-Hill), 1996.
2.	Martin L. Shooman; Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design; John Wiley & Sons Inc., 2002.
3.	D. K. Pradhan, Fault Tolerant Computer System design, Prentice Hall.(1996).
4.	Morozov, Andrey, Silvia Vock, Kai Ding, Stefan Voss, and Klaus Janschek. "Industry 4.0: Emerging challenges for dependability analysis." Industry 4.0 4, no. 5 (2019): 206-209.
5.	Elena Dubrova; Fault-Tolerant Design; Springer, 2013. (Module 1, 2, 3)

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

MDI4012	Vision and Image processing	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**NIL**	**Syllabus version**				
		1.0				

Course Objectives:

1. To provide basic and fundamental knowledge on different phases of digital image processing.
2. The course also aims to cover the processing of colored images.
3. The course also aims to cover techniques and tools for digital image processing, and to provide hands-on experience in applying these tools to process images.

Course Outcomes:

1. Explain the fundamentals of digital image processing and pixel geometry.
2. Demonstrate different techniques of bilevel and grey level image processing.
3. Explain the basic principle of image segmentation, different types of segmentation methods and their used in real applications.
4. Demonstrate image enhancement techniques used in spatial and frequency domain.
5. Explain the fundamental knowledge about image restoration, registration and feature extraction techniques used in digital image processing.
6. Demonstrate the basic of image compression and different lossy and lossless compression techniques.
7. Explain different techniques used for image representation as well as description and the application in real time vision system.

Module:1	**Digital Image Fundamentals**	**5 hours**

The eye; Image Acquisition Systems; A simple image model: Brightness, Contrast; Sampling and Quantization; Digital Imaging Geometry: pixel geometry, neighbors of pixels; Different types of digital images: bilevel images, grey level images, color images; Color Representation; chromaticity diagram.

Module:2	**Bilevel and Gray Level Image Processing**	**6 hours**

Basic concepts of digital distances, distance transform, arithmetic operations, medial axis transform, component labeling, thinning, morphological processing, extension to gray scale morphology.

Module:3	**Image Segmentation**	**6 hours**

Pixel-based Segmentation, Multilevel and Adaptive Thresholding, Optimal Thresholding, Region-based Segmentation, Point, Line, and Edge detection, Water shade algorithm for segmenting grey level image, Hough Transform, Color Image Segmentation.

Module:4	**Image Enhancement**	**7 hours**

Enhancement by point processing, Sample intensity transformation, Histogram processing, Image subtraction, Image averaging, Spatial filtering- Smoothing Spatial filters, Sharpening Spatial filters, Frequency domain- Fourier Transform, Low-Pass, HighPass, Laplacian, Homomorphic filtering, color image enhancement.

Module:5	**Image Restoration, Registration and Feature Extraction**	**5 hours**

Noise Models, Image Restoration Filtering, Image Estimation, Geometric Transformation, Registration Algorithms, Stereo Imaging, Overview of shape, texture and color features.

Module:6	**Image Compression**	**6 hours**

Image compression standards, Coding redundancy, Interpixel redundancy, fidelity criteria, Image compression models, Error Criterion, Error-free compression, Variable length coding, Bit-plane coding, Lossless predictive coding, Lossy compression, JPEG compression standard, Fractal compression scheme, Wavelet compression scheme, Real-Time image transmission.

Module:7	**Image Representation, Description and Vision Systems**	**8 hours**

Freeman Chain Coding; Binary Tree and Quad Tree Coding; Boundary Descriptors; Regional Descriptors; Topological Descriptors; Relational Descriptors, Real time vision

systems: face detection and recognition.				
Module:8	**Contemporary Issues**			**2 hours**
			Total Lecture hours:	**45 hours**
Text Book(s)				
1.	R C Gonzalez & R E Woods, Digital Image Processing, Pearson Education, 4th Edition, 2018.			
Reference Books				
1.	B. Chanda and D. Dutta Mazumdar, Digital Image Processing and Analysis, PHI, 2011.			
2.	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.			
3.	William K Pratt, "Digital Image Processing", Wiley, 4th Edition, 2012			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Challenging Experiments: (Indicative)				
1.	Digital image conversion from RGB to grey, grey to binary, Image transformations			3 hours
2.	Image enhancement using Histogram Equalization, Sharpening and smoothing filters			3 hours
3.	Morphological operations			3 hours
4.	Comparison of edge detection techniques			3 hours
5.	Noise analysis			3 hours
6	Fourier transform on images			3 hours
7	Image compression using Bit plane slicing			3 hours
8	Image compression using DCT			3 hours
9	Image Segmentation			3 hours
10	Color Image processing			3 hours
			Total Laboratory Hours	30 hours
Mode of assessment: CAT / Assignment / FAT				
Recommended by Board of Studies		25-10-2021		
Approved by Academic Council		No. 64	Date	16-12-2021

CHY1701 Engineering Chemistry		L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Chemistry of 12th standard or equivalent**	**Syllabus version**				
		1.0				

Course Objectives:

- To impart technological aspects of applied chemistry
- To lay foundation for practical application of chemistry in engineering aspects

Expected Course Outcome:

- Students will be familiar with the water treatment, corrosion and its control, engineering applications of polymers, types of fuels and their applications, basic aspects of electrochemistry and electrochemical energy storage devices
-

Student Learning Outcomes (SLO): 1,2,14

Module:1	Water Technology	5 hours	SLO: 1,14

Characteristics of hard water - hardness, DO, TDS in water and their determination – numerical problems in hardness determination by EDTA; Modern techniques of water analysis for industrial use - Disadvantages of hard water in industries.

Module:2	Water Treatment	8 hours	SLO:1,14

Water softening methods: - Lime-soda, Zeolite and ion exchange processes and their applications. Specifications of water for domestic use (ICMR and WHO); Unit processes involved in water treatment for municipal supply - Sedimentation with coagulant- Sand Filtration - chlorination; Domestic water purification – Candle filtration- activated carbon filtration; Disinfection methods- Ultrafiltration, UV treatment, Ozonolysis, Reverse Osmosis; Electro dialysis.

Module:3	Corrosion	6 hours	SLO: 2

Dry and wet corrosion - detrimental effects to buildings, machines, devices & decorative art forms, emphasizing Differential aeration, Pitting, Galvanic and Stress corrosion cracking; Factors that enhance corrosion and choice of parameters to mitigate corrosion.

Module:4	Corrosion Control	4 hours	SLO: 2

Corrosion protection - cathodic protection – sacrificial anodic and impressed current protection methods; Advanced protective coatings: electroplating and electroless plating, PVD and CVD.

Alloying for corrosion protection – Basic concepts of Eutectic composition and Eutectic mixtures - Selected examples – Ferrous and non-ferrous alloys.

Module:5	Electrochemical Energy Systems	6 hours	SLO: 1,14

Brief introduction to conventional primary and secondary batteries; High energy electrochemical energy systems: Lithium batteries – Primary and secondary, its Chemistry, advantages and applications.
Fuel cells – Polymer membrane fuel cells, Solid-oxide fuel cells- working principles, advantages, applications.
Solar cells – Types – Importance of silicon single crystal, polycrystalline and amorphous silicon solar cells, dye sensitized solar cells - working principles, characteristics and applications.

Module:6	Fuels and Combustion	8 hours	SLO: 2
Calorific value - Definition of LCV, HCV. Measurement of calorific value using bomb calorimeter and Boy's calorimeter including numerical problems. Controlled combustion of fuels - Air fuel ratio – minimum quantity of air by volume and by weight-Numerical problems-three way catalytic converter- selective catalytic reduction of NO_X; Knocking in IC engines-Octane and Cetane number - Antiknocking agents.			
Module:7	**Polymers**	**6 hours**	**SLO: 2**
Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - ABS, PVC, PTFE and Bakelite; Compounding of plastics: moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays, (Compression moulding), Fibre reinforced polymers, Composites (Transfer moulding), PET bottles (blow moulding); Conducting polymers- Polyacetylene- Mechanism of conduction – applications (polymers in sensors, self-cleaning windows)			
Module:8	**Contemporary issues:**	**2 hours**	
Lecture by Industry Experts			
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	1. Sashi Chawla, A Text book of Engineering Chemistry, Dhanpat Rai Publishing Co., Pvt. Ltd., Educational and Technical Publishers, New Delhi, 3rd Edition, 2015. 2. O.G. Palanna, McGraw Hill Education (India) Private Limited, 9th Reprint, 2015. 3. B. Sivasankar, Engineering Chemistry 1st Edition, Mc Graw Hill Education (India), 2008 4. "Photovoltaic solar energy: From fundamentals to Applications", AngÃ¨le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Wiley publishers, 2017.
Reference Books	
2	1. O.V. Roussak and H.D. Gesser, ***Applied Chemistry-A Text Book for Engineers and Technologists***, Springer Science Business Media, New York, 2nd Edition, 2013. 2. S. S. Dara, ***A Text book of Engineering Chemistry,*** S. Chand & Co Ltd., New Delhi, 20th Edition, 2013.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT

List of Challenging Experiments (Indicative)		**SLO: 14**
	Experiment title	Hours
1.	Water Purification : Hardness estimation by EDTA method and removal by ion-exchange resin	1 h 30 min
2. 3.	Water Quality monitoring: Total dissolved oxygen assessment in different water samples by Winkler's method Estimation of Sulphate for assessing water contamination by conductivity method	3 h

4. 5.	Material Analysis: Nickel in Nickel plated component by colorimetry Iron in carbon steel by potentiometry	3h
6.	Measurement of Retrieved water stored in smart material (hydrogel)	1 h 30 min
7.	Polymer characterization: Determination of viscosity of different natural polymer/synthetic polymers	1 h 30 min
8. 9.	Soil analysis by flame photometry: Na/K in soil & Ca in water samples	3h
10.	Preparation of a working model relevant to syllabus and its demonstration. Examples: 1. Construction and working of electrochemical energy system – students should demonstrate working of the system. 2. Construction of dye sensitized solar cell and demonstration of its working 3. Calcium in food samples	Non-contact hours
	Total Laboratory Hours	17 hours
Mode of Evaluation: Viva-voce and Lab performance & FAT		
Recommended by Board of Studies	06-06-2018	
Approved by Academic Council	**50th ACM** Date **14.06.2018**	

CSE1001	PROBLEM SOLVING AND PROGRAMMING	L	T	P	J	C
		0	0	6	0	3
Pre-requisite	NIL	Syllabus version				
		1.0				

Course Objectives:

1. To develop broad understanding of computers, programming languages and their generations
2. Introduce the essential skills for a logical thinking for problem solving
3. To gain expertise in essential skills in programming for problem solving using computer

Expected Course Outcome:

1. Understand the working principle of a computer and identify the purpose of a computer programming language.
2. Learn various problem solving approaches and ability to identify an appropriate approach to solve the problem
3. Differentiate the programming Language constructs appropriately to solve any problem
4. Solve various engineering problems using different data structures
5. Able to modulate the given problem using structural approach of programming
6. Efficiently handle data using flat files to process and store data for the given problem

Student Learning Outcomes (SLO):	1, 12, 14

	List of Challenging Experiments (Indicative)	
1	Steps in Problem Solving Drawing flowchart using yEd tool/Raptor Tool	4 Hours
2	Introduction to Python, Demo on IDE, Keywords, Identifiers, I/O Statements	4 Hours
3	Simple Program to display Hello world in Python	4 Hours
4	Operators and Expressions in Python	4 Hours
5	Algorithmic Approach 1: Sequential	4 Hours
6	Algorithmic Approach 2: Selection (if, elif, if.. else, nested if else)	4 Hours
7	Algorithmic Approach 3: Iteration (while and for)	6 Hours
8	Strings and its Operations	6 Hours
9	Regular Expressions	6 Hours
10	List and its operations	6 Hours
11	Dictionaries: operations	6 Hours

12	Tuples and its operations	6 Hours
13	Set and its operations	6 Hours
14	Functions, Recursions	6 Hours
15	Sorting Techniques (Bubble/Selection/Insertion)	6 Hours
16	Searching Techniques : Sequential Search and Binary Search	6 Hours
17	Files and its Operations	6 Hours
	Total hours:	**90 hours**

Text Book(s)

1.	John V. Guttag., 2016. Introduction to computation and programming using python: with applications to understanding data. PHI Publisher.

Reference Books

1.	Charles Severance.2016.Python for everybody: exploring data in Python 3, Charles Severance.
2.	Charles Dierbach.2013.Introduction to computer science using python: a computational problem-solving focus. Wiley Publishers.

Mode of Evaluation: **PAT / CAT / FAT**

Recommended by Board of Studies			
Approved by Academic Council	No. 37	Date	16-06-2015

CSE1002	PROBLEM SOLVING AND OBJECT ORIENTED PROGRAMMING	L	T	P	J	C
		0	0	6	0	3

Pre-requisite	Nil	Syllabus version
		1.0

Course Objectives:

1. To emphasize the benefits of object oriented concepts.

2.To enable students to solve the real time applications using object oriented programming features

3.To improve the skills of a logical thinking and to solve the problems using any processing elements

Expected Course Outcome:

1. Demonstrate the basics of procedural programming and to represent the real world entities as programming constructs.

2.Enumerate object oriented concepts and translate real-world applications into graphical representations.

3.Demonstrate the usage of classes and objects of the real world entities in applications.
4.Discriminate the reusability and multiple interfaces with same functionality based features to

solve complex computing problems.

5.Illustrate possible error-handling constructs for unanticipated states/inputs and to use generic programming constructs to accommodate different datatypes.

6.Validate the program against file inputs towards solving the problem..

Student Learning Outcomes (SLO):	1,9,17

List of Challenging Experiments (Indicative)

1.	**Postman Problem** A postman needs to walk down every street in his area in order to deliver the mail. Assume that the distances between the streets along the roads are given. The postman starts at the post office and returns back to the post office after delivering all the mails. Implement an algorithm to help the post man to walk minimum distance for the purpose.	10 hours
2.	**Budget Allocation for Marketing Campaign** A mobile manufacturing company has got several marketing options such as	15 hours

	Radio advertisement campaign, TV non peak hours campaign, City top paper network, Viral marketing campaign, Web advertising. From their previous experience, they have got a statistics about paybacks for each marketing option. Given the marketing budget (rupees in crores) for the current year and details of paybacks for each option, implement an algorithm to determine the amount that shall spent on each marketing option so that the company attains the maximum profit.	
3.	**Missionaries and Cannibals** Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Implement an algorithm to find a way to get everyone to the other side of the river, without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place.	10 hours
4.	**Register Allocation Problem** A register is a component of a computer processor that can hold any type of data and can be accessed faster. As registers are faster to access, it is desirable to use them to the maximum so that the code execution is faster. For each code submitted to the processor, a register interference graph (RIG) is constructed. In a RIG, a node represents a temporary variable and an edge is added between two nodes (variables) t1 and t2 if they are live simultaneously at some point in the program. During register allocation, two temporaries can be allocated to the same register if there is no edge connecting them. Given a RIG representing the dependencies between variables in a code, implement an algorithm to determine the number of registers required to store the variables and speed up the code execution	15 hours
5.	**Selective Job Scheduling Problem** A server is a machine that waits for requests from other machines and responds to them. The purpose of a server is to share hardware and software resources among clients. All the clients submit the jobs to the server for execution and the server may get multiple requests at a time. In such a situation, the server schedule the jobs submitted to it based on some criteria and logic. Each job contains two values namely time and memory required for execution. Assume that there are two servers that schedules jobs based on time and memory. The servers are named as Time Schedule Server and memory Schedule Server respectively. Design a OOP model and implement the time Schedule Server and memory Schedule Server. The Time Schedule Server arranges jobs based on time required for execution in ascending order whereas memory Schedule Server arranges jobs based on memory required for execution in ascending order	15 hours
6.	**Fragment Assembly in DNA Sequencing** DNA, or deoxyribonucleic acid, is the hereditary material in humans and	15 hours

	almost all other organisms. The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). In DNA sequencing, each DNA is sheared into millions of small fragments (reads) which assemble to form a single genomic sequence (superstring). Each read is a small string. In such a fragment assembly, given a set of reads, the objective is to determine the shortest superstring that contains all the reads. For example, given a set of strings, 000, 001, 010, 011, 100, 101, 110, 111 the shortest superstring is 0001110100. Given a set of reads, implement an algorithm to find the shortest superstring that contains all the given reads.	
7.	**House Wiring** An electrician is wiring a house which has many rooms. Each room has many power points in different locations. Given a set of power points and the distances between them, implement an algorithm to find the minimum cable required.	10 hours
	Total Laboratory Hours	**90 hours**

Text Book(s)	
1.	Stanley B Lippman, Josee Lajoie, Barbara E, Moo, C++ primer, Fifth edition, Addison-Wesley, 2012.
2	Ali Bahrami, Object oriented Systems development, Tata McGraw - Hill Education, 1999.
3	Brian W. Kernighan, Dennis M. Ritchie , The C programming Language, 2nd edition, Prentice Hall Inc., 1988.

Reference Books	
1.	Bjarne stroustrup, The C++ programming Language, Addison Wesley, 4th edition, 2013
2.	Harvey M. Deitel and Paul J. Deitel, C++ How to Program, 7th edition, Prentice Hall, 2010
3.	Maureen Sprankle and Jim Hubbard, Problem solving and Programming concepts, 9th edition, Pearson Eduction, 2014.

Mode of assessment: **PAT / CAT / FAT**			
Recommended by Board of Studies	04-04-2014		
Approved by Academic Council	No. 37	Date	16-06-2015

CSI1006	Mini Project	L	T	P	J	C
		0	0	0	0	4
Pre-requisite	**NIL**	**Syllabus version**				
		1.0				

Course Objectives:

1. To develop and provide hands-on learning with their own innovative prototype of ideas in preparing mini project reports and to enhance technical skill in the preferred field
2. To discover the solution of identifying problem with help of modern technology

Course Outcomes:

At the end of the course the student will be able to

1. Understand literature with the purpose of formulating a project topic
2. Identify real word problems and research issues
3. Design and Analysis Problem Statements and propose solutions.
4. Perform error analysis / benchmarking / costing
5. Work as a team and to focus on getting a working project done within a stipulated period of time.
6. Synthesize the results and arrive at scientific conclusions / products / solution
7. Document the results in the form of technical report / presentation

Contents:

1. Students will be able to take up this course after the completion of minimum 120 credits
2. The project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, correlation and analysis of data, software development, Full-stack web and mobile app development, applied research with AI tools and technologies and any other related activities.
3. Project is for one semester based on the completion of required number of credits as per the academic regulations.
4. Should be individual or group (Restricted to maximum of 4 members)
5. Carried out inside the university
6. Publications in the peer reviewed journals / International Conferences and patent filing will be an added advantage
7. The weightage for the guide mark is 25
8. The project component to have three reviews with the weightage of 15:20:40

Mode of Evaluation: Periodic reviews, Presentation, Paper Publication

Recommended by Board of Studies	25-10-2021		
Approved by Academic Council	64	Date	16-12-2021

Course Code	Course Title	L	T	P	J	C
CSI3901	Technical Answers for Real World Problems (TARP)	1	0	0	4	2
Pre-requisite	PHY1901 and 143 Credits Earned	Syllabus version				
		1.0				

Course Objectives

1. To assist the students in identifying industrial and societal problems and help develop new technologies to solve them.
2. To guide the students in building robust and efficient prototypes/products.
3. To train the students to analyze the developed prototypes using the methodologies/criteria available.

Course Outcomes

Upon successful completion of the course the students will be able to

1. Identify industrial and societal problems that can be solved using science engineering principles.
2. Develop novel solutions to solve the identified problems.

Module:1		2 hours

1. Spotting real life problems and formulating engineering solutions.
2. Students can be taken on industrial/field visits to gather relevant information.
3. Teams can be formed in a group of maximum 5.
4. Eight hours of dedicated team activity is required for completion of the project.
5. A survey of state-of-the-art technologies/methodologies that can be used to solve the problem.
6. The proposed prototype/solution must be in the form of fabrication/ coding/modeling/product design/process design/relevant scientific methodologies.
7. A consolidated report must be submitted for evaluation.
8. Students' contribution, presentation, and progress over the course of the project will be considered for the continuous assessment of the theory component.
9. The outcome will be evaluated in terms of technical, economic, social, environmental, political, and demographic feasibility.
10. Each group member should have made significant contribution to the overall project.

Mode of Evaluation: (No FAT) Continuous Assessment of the project in three reviews with mark weightage of 20:30:50 - project report to be submitted.

Recommended by Board of Studies	18-11-2022		
Approved by Academic Council	No. 68	Date	19-12-2022

ENG1901	Technical English - I	L	T	P	J	C
		0	0	4	0	2
Pre-requisite		Syllabus Version				
		1.0				

Course Objectives:

1. To enhance students' knowledge of grammar and vocabulary to read and write error-free language in real life situations.
2. To make the students' practice the most common areas of written and spoken communications skills.
3. To improve students' communicative competency through listening and speaking activities in the classroom.

Expected Course Outcome:

1. Develop a better understanding of advanced grammar rules and write grammatically correct sentences.
2. Acquire wide vocabulary and learn strategies for error-free communication.
3. Comprehend language and improve speaking skills in academic and social contexts.
4. Improve listening skills so as to understand complex business communication in a variety of global English accents through proper pronunciation.
5. Interpret texts, diagrams and improve both reading and writing skills which would help them in their academic as well as professional career.

Student Learning Outcomes (SLO):	3,16, 18	
Module:1	**Advanced Grammar**	**4 hours**

Articles, Tenses, Voice and Prepositions
Activity: Worksheets on Impersonal Passive Voice, Exercises from the prescribed text

Module:2	**Vocabulary Building I**	**4 hours**

Idioms and Phrases, Homonyms, Homophones and Homographs
Activity: Jigsaw Puzzles; Vocabulary Activities through Web tools

Module:3	**Listening for Specific Purposes**	**4 hours**

Gist, monologues, short conversations, announcements, briefings and discussions
Activity: Gap filling; Interpretations

Module:4	**Speaking for Expression**	**6 hours**

Introducing oneself and others, Making Requests & responses, Inviting and Accepting/Declining Invitations.
Activity: Brief introductions; Role-Play; Skit.

Module:5	**Reading for Information**	**4 hours**

Reading Short Passages, News Articles, Technical Papers and Short Stories
Activity: Reading specific news paper articles; blogs

Module:6	**Writing Strategies**	**4 hours**

Joining the sentences, word order, sequencing the ideas, introduction and conclusion
Activity: Short Paragraphs; Describing familiar events; story writing

Module:7	**Vocabulary Building II**	**4 hours**

Enrich the domain specific vocabulary by describing Objects, Charts, Food, Sports and Employment. Activity: Describing Objects, Charts, Food, Sports and Employment

Module:8	**Listening for Daily Life**	**4 hours**

Listening for statistical information, Short extracts, Radio broadcasts and TV interviews
Activity: Taking notes and Summarizing

Module:9	**Expressing Ideas and Opinions**	**6 hours**

Telephonic conversations, Interpretation of Visuals and describing products and processes.
Activity: Role-Play (Telephonic); Describing Products and Processes

Module: 10	**Comprehensive Reading**	**4 hours**

Reading Comprehension, Making inferences, Reading Graphics, Note-making, and Critical Reading. Activity: Sentence Completion; Cloze Tests		
Module: 11	**Narration**	**4 hours**
Writing narrative short story, Personal milestones, official letters and E-mails. Activity: Writing an E-mail; Improving vocabulary and writing skills.		
Module:12	**Pronunciation**	**4 hours**
Speech Sounds, Word Stress, Intonation, Various accents Activity: Practicing Pronunciation through web tools; Listening to various accents of English		
Module:13	**Editing**	**4 hours**
Simple, Complex & Compound Sentences, Direct & Indirect Speech, Correction of Errors, Punctuations. Activity: Practicing Grammar		
Module:14	**Short Story Analysis**	**4 hours**
"The Boundary" by Jhumpa Lahiri Activity: Reading and analyzing the theme of the short story.		
Total Lecture hours:		**60 hours**

Text Book / Workbook	
1.	Wren, P.C.; Martin, H.; Prasada Rao, N.D.V. (2015). *High School English Grammar & Composition*. New Delhi: Sultan Chand Publishers.
2	Kumar, Sanjay,; Pushp Latha. (2018) English Language and Communication Skills for Engineers, India: Oxford University Press.
Reference Books	
1	Leech, G. & J. Svartvik. (2016) *A Communicative Grammar of English*, India: Pearson.
2	Steven Brown, (2015) Dorolyn Smith, *Active Listening 3*, 3rd Edition, UK: Cambridge University Press.
3	Liz Hamp-Lyons, Ben Heasley, (2016) *Study Writing*, 2nd Edition, UK: Cambridge University Pres.
4	Kenneth Anderson, Joan Maclean, (2014) Tony Lynch, *Study Speaking*, 2nd Edition, UK: Cambridge, University Press
5	Eric H. Glendinning, Beverly Holmstrom, (2014) *Study Reading*, 2nd Edition, UK: Cambridge University Press.
6	Michael Swan, (2017) *Practical English Usage* (Practical English Usage), 4th edition, UK: Oxford University Press.
7	Michael McCarthy, Felicity O'Dell, (2015) *English Vocabulary in Use Advanced* (South Asian Edition), UK: Cambridge University Press.
8	Michael Swan, Catherine Walter, (2016) *Oxford English Grammar Course Advanced*, Feb, 4th Edition, UK: Oxford University Press.
9	Watkins, Peter. (2018) *Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers*, UK: Cambridge University Press
10	(*The Boundary by Jhumpa Lahiri)* URL: https://www.newyorker.com/magazine/2018/01/29/the-boundary?intcid=inline_amp
Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT	
List of Challenging Experiments (Indicative)	

1.	Self-Introduction	
2.	Sequencing Ideas and Writing a Paragraph	
3.	Reading and Analyzing Technical Articles	
4.	Listening for Specificity in Interviews (Content Specific)	
5.	Identifying Errors in a Sentence or Paragraph	
6.	Writing an E-mail by narrating life events	
Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT		
Recommended by Board of Studies	08.06.2019	
Approved by Academic Council	55	Date: 13.06.2019

ENG1902	Technical English - II	L	T	P	J	C
		0	0	4	0	2
Pre-requisite		Syllabus Version				
		1.0				

Course Objectives:

1. To acquire proficiency levels in LSRW skills on par with the requirements for placement interviews of high-end companies / competitive exams.
2. To evaluate complex arguments and to articulate their own positions on a range of technical and general topics.
3. To speak in grammatical and acceptable English with minimal MTI, as well as develop a vast and active vocabulary.

Expected Course Outcome:

1. Communicate proficiently in high-end interviews and exam situations and all social situations
2. Comprehend academic articles and draw inferences
3. Evaluate different perspectives on a topic
4. Write clearly and convincingly in academic as well as general contexts
5. Synthesize complex concepts and present them in speech and writing

Student Learning Outcomes (SLO):	3,16, 18

Module:1	Listening for Clear Pronunciation	4 hours

Ice-breaking, Introduction to vowels, consonants, diphthongs.
Listening to formal conversations in British and American accents (BBC and CNN) as well as other 'native' accents
Activity: Factual and interpretive exercises; note-making in a variety of global English accents

Module:2	Introducing Oneself	4 hours

Speaking: Individual Presentations
Activity: Self-Introductions, Extempore speech

Module:3	Effective Writing	6 hours

Writing: Business letters and Emails, Minutes and Memos
Structure/ template of common business letters and emails: inquiry/ complaint/ placing an order; Formats of Minutes and Memos
Activity: Students write a business letter and Minutes/ Memo

Module:4	Comprehensive Reading	4 hours

Reading: Reading Comprehension Passages, Sentence Completion (Technical and General Interest), Vocabulary and Word Analogy
Activities: Cloze tests, Logical reasoning, Advanced grammar exercises

Module:5	Listening to Narratives	4 hours

Listening: Listening to audio files of short stories, News, TV Clips/ Documentaries, Motivational Speeches in UK/ US/ global English accents.
Activity: Note-making and Interpretive exercises

Module:6	Academic Writing and Editing	6 hours

Writing: Editing/ Proofreading symbols
Citation Formats
Structure of an Abstract and Research Paper
Activity: Writing Abstracts and research paper; Work with Editing/ Proofreading exercise

Module:7	Team Communication	4 hours

Speaking: Group Discussions and Debates on complex/ contemporary topics
Discussion evaluation parameters, using logic in debates
Activity: Group Discussions on general topics

Module:8	**Career-oriented Writing**	**4 hours**
Writing: Resumes and Job Application Letters, SOP Activity: Writing resumes and SOPs		
Module:9	**Reading for Pleasure**	**4 hours**
Reading: Reading short stories Activity: Classroom discussion and note-making, critical appreciation of the short story		
Module: 10	**Creative Writing**	**4 hours**
Writing: Imaginative, narrative and descriptive prose Activity: Writing about personal experiences, unforgettable incidents, travelogues		
Module: 11	**Academic Listening**	**4 hours**
Listening: Listening in academic contexts Activity: Listening to lectures, Academic Discussions, Debates, Review Presentations, Research Talks, Project Review Meetings		
Module:12	**Reading Nature-based Narratives**	**4 hours**
Narratives on Climate Change, Nature and Environment Activity: Classroom discussions, student presentations		
Module:13	**Technical Proposals**	**4 hours**
Writing: Technical Proposals Activities: Writing a technical proposal		
Module:14	**Presentation Skills**	**4 hours**
Persuasive and Content-Specific Presentations Activity: Technical Presentations		
Total Lecture hours:		**60 hours**

Text Book / Workbook	
1.	Oxenden, Clive and Christina Latham-Koenig. *New English File: Advanced Students Book*. Paperback. Oxford University Press, UK, 2017.
2	Rizvi, Ashraf. *Effective Technical Communication*. McGraw-Hill India, 2017.
Reference Books	
1.	Oxenden, Clive and Christina Latham-Koenig, *New English File: Advanced: Teacher's Book with Test and Assessment*. CD-ROM: Six-level General English Course for Adults. Paperback. Oxford University Press, UK, 2017.
2.	Balasubramanian, T. *English Phonetics for the Indian Students: A Workbook*. Laxmi Publications, 2015.
3.	Philip Seargeant and Bill Greenwell, *From Language to Creative Writing*. Bloomsbury Academic, 2016.
4.	Krishnaswamy, N. *Eco-English*. Bloomsbury India, 2016.
5.	Manto, Saadat Hasan. *Selected Short Stories*. Trans. Aatish Taseer. Random House India, 2017.
6.	Marquez, Gabriel Garcia. *Chronicle of a Death Foretold*. Penguin India, 2016.
7.	Ghosh, Amitav. *The Hungry Tide*. Harper Collins, 2017.
8.	Ghosh, Amitav. *The Great Derangement: Climate Change and the Unthinkable*. Penguin Books, 2016.
9.	Carson, Rachel. *Silent Spring*. Penguin Modern Classics, 2014.
10.	Crystal, David. *Language and the Internet*. Cambridge University Press, 2016.
11.	*The MLA Handbook for Writers of Research Papers,* 8th ed. 2016.

	Online Sources: https://americanliterature.com/short-short-stories. (75 *short* short stories) http://www.eco-ction.org/dt/thinking.html (Leopold, Aldo."Thinking like a Mountain") https://www.esl-lab.com/; http://www.bbc.co.uk/learningenglish/; https://www.bbc.com/news; https://learningenglish.voanews.com/a/using-voa-learning-english-to-improve-listening-skills/3815547.html

Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT

List of Challenging Experiments (Indicative)		
1.	Self-Introduction using SWOT	
2.	Writing minutes of meetings	
3.	Writing an abstract	
4.	Listening to motivational speeches and interpretation	
5.	Cloze Test	
6.	Writing a proposal	

Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT

Recommended by Board of Studies	08.06.2019	
Approved by Academic Council	55	Date: 13.06.2019

ENG1903	Advanced Technical English	L	T	P	J	C
		0	0	2	4	2
Pre-requisite		Syllabus Version				
		1.0				

Course Objectives:

1. To review literature in any form or any technical article
2. To infer content in social media and respond accordingly
3. To communicate with people across the globe overcoming trans-cultural barriers and negotiate successfully

Expected Course Outcome:

1. Analyze critically and write good reviews
2. Articulate research papers, project proposals and reports
3. Communicate effectively in a trans-cultural environment
4. Negotiate and lead teams towards success
5. Present ideas in an effective manner using web tools

Student Learning Outcomes (SLO): 3,16, 18

Module:1	Negotiation and Decision Making Skills through Literary Analysis	5 hours

Concepts of Negotiation and Decision Making Skills

Activity:

Analysis of excerpts from Shakespeare's "The Merchant of Venice" (court scene) and discussion on negotiation skills.

Critical evaluation of excerpts from Shakespeare's "Hamlet"(Monologue by Hamlet) and discussion on decision making skills

Module:2	Writing reviews and abstracts through movie interpretations	5 hours

Review writing and abstract writing with competency

Activity:

Watching Charles Dickens "Great Expectations" and writing a movie review

Watching William F. Nolan's "Logan's Run" and analyzing it in tune with the present scenario of depletion of resources and writing an abstract

Module:3	Technical Writing	4 hours

Stimulate effective linguistics for writing: content and style

Activity: Proofreading, Statement of Purpose

Module:4	Trans-Cultural Communication	4 hours

Nuances of Trans-cultural communication

Activity:

Group discussion and case studies on trans-cultural communication.

Debate on trans-cultural communication.

Module:5	Report Writing and Content Writing	4 hours

Enhancing reportage on relevant audio-visuals

Activity:

Watch a documentary on social issues and draft a report

Identify a video on any social issue and interpret

Module:6	Drafting project proposals and article writing	4 hours

Dynamics of drafting project proposals and research articles

Activity:

Writing a project proposal.

Writing a research article.

Module:7	Technical Presentations	4 hours

Build smart presentation skills and strategies

Activity: Technical presentations using PPT and Web tools		
Total Lecture hours:		**30 hours**
Text Book / Workbook		
1.	Raman, Meenakshi & Sangeeta Sharma. *Technical Communication: Principles and Practice*, 3rd edition, Oxford University Press, 2015.	
Reference Books		
1	Basu B.N. *Technical Writing*, PHI Learning Pvt. Ltd., 2017.	
2	Arathoon, Anita. *Shakespeare's The Merchant of Venice* (Text with Paraphrase), Evergreen Publishers, 2015.	
3	Kumar, Sanjay and Pushp Lata. *English Language and Communication Skills for Engineers,* Oxford University Press, India, 2018.	
4	Frantisek, Burda. *On Transcultural Communication*, 2015, LAP Lambert Academic Publishing, UK.	
5	Geever, C. Jane. *The Foundation Center's Guide to Proposal Writing*, 5th Edition, 2017, The Foundation Center, USA.	
6	Young, Milena. *Hacking Your Statement of Purpose: A Concise Guide to Writing Your SOP*, Kindle Edition.	
7	Ray, Ratri, *William Shakespeare's Hamlet*, The Atlantic Publishers, 2014.	
8	C Muralikrishna & Sunitha Mishra, *Communication Skills for Engineers,* 2nd edition, NY: Pearson, 2015.	
Mode of Evaluation: Quizzes, Presentation, Discussion, Role Play, Assignments		

List of Challenging Experiments (Indicative)		
1.	Enacting a court scene - Speaking	
2.	Watching a movie and writing a review	
3.	Trans-cultural – case studies	
4.	Drafting a report on any social issue	
5.	Technical Presentation using web tools	
6.	Writing a research paper	
J- Component Sample Projects		
1.	Short Films	
2.	Field Visits and Reporting	
3.	Case studies	
4.	Writing blogs	
5.	Vlogging	
	Total Hours (J-Component)	**60 Hours**
Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT		

Recommended by Board of Studies	08.06.2019	
Approved by Academic Council	55	Date: 13.06.2019

HUM1021	ETHICS AND VALUES	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	**Nil**	**Syllabus version**				
		1.2				

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity
2. To understand the negative health impacts of certain unhealthy behaviors
3. To appreciate the need and importance of physical, emotional health and social health

Expected Course Outcome:

Students will be able to:

1. Follow sound morals and ethical values scrupulously to prove as good citizens
2. Understand varioussocial problems and learn to act ethically
3. Understand the concept of addiction and how it will affect the physical and mental health
4. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
5. Identify the main typologies, characteristics, activities, actors and forms of cybercrime

Student Learning Outcomes (SLO):	2, 10, 11, 12	
Module: 1	**Being good and responsible**	**5 hours**
Gandhian values such as truth and non-violence – comparative analysis on leaders of past and present – society's interests versus self-interests–Personal Social Responsibility: Helping the needy, charity and serving the society.		
Module: 2	**Social Issues 1**	**4 hours**
Harassment – types - Prevention of harassment, violence and terrorism		
Module: 3	**Social Issues 2**	**4 hours**
Corruption: ethical values, causes, impact, laws, prevention – electoral malpractices white collar crimes – tax evasions – unfair trade practices		
Module: 4	**Addiction and Health**	**3 hours**
Peer pressure - Alcoholism: ethical values, causes, impact, laws, prevention – Ill effects of smoking – Prevention of Suicides Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases		
Module: 5	**Drug Abuse**	**4 hours**
Abuse of different types of legal and illegal drugs: ethical values, causes, impact, laws and prevention		
Module: 6	**Personal and Professional Ethics**	**3 hours**
Dishonesty - Stealing - Malpractices in Examinations – Plagiarism		
Module: 7	**Abuse of technologies**	**4 hours**
Hacking and other cyber crimes, addiction to mobile phone usage, video games and social networking websites		
Module: 8	**Invited Talk:** Contemporary Issues	**3 hours**
Total Lecture hours		**30 hours**

Reference Books

1.	Dhaliwal, K.K (2016), "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts, Writers Choice, New Delhi, India
2.	Vittal, N (2012), "Ending Corruption? - How to Clean up India?", Penguin Publishers, UK
3.	Pagliaro, L.A. and Pagliaro, A.M (2012), "Handbook of Child and Adolescent Drug and

	Substance Abuse: Pharmacological , Developmental and Clinical Considerations", Wiley Publishers, U.S.A		
4.	Pandey, P. K (2012), "Sexual Harassment and Law in India", Lambert Publishers, Germany		
Mode of Evaluation: CAT, Assignment, Quiz, FAT and Seminar			
Recommended by Board of Studies	26.07.2017		
Approved by Academic Council	46th ACM	**Date**	24.08.2017

MAT1011	Calculus for Engineers	L	T	P	J	C
		3	0	2	0	4
Pre-requisite		Syllabus Version				
		1.0				

Course Objectives :

1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.
3. To impart the knowledge of Laplace transform, an important transform technique for Engineers which requires knowledge of integration

Expected Course Outcomes:

At the end of this course the students should be able to

1. apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions
2. understand basic concepts of Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution
3. evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints
4. evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.
5. understand gradient, directional derivatives, divergence, curl and Greens', Stokes, Gauss theorems
6. demonstrate MATLAB code for challenging problems in engineering

Student Learning Outcome (SLO):	1, 2, 9

Module:1	Application of Single Variable Calculus	9 hours

Differentiation- Extrema on an Interval-Rolle's Theorem and the Mean Value Theorem-Increasing and Decreasing functions and First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution - Beta and Gamma functions–interrelation

Module:2	Laplace transforms	7 hours

Definition of Laplace transform-Properties-Laplace transform of periodic functions-Laplace transform of unit step function, Impulse function-Inverse Laplace transform-Convolution.

Module:3	Multivariable Calculus	4 hours

Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.

Module:4	**Application of Multivariable Calculus**	**5 hours**
Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method.		
Module:5	**Multiple integrals**	**8 hours**
Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - Evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates- evaluation of multiple integrals using gamma and beta functions.		
Module:6	**Vector Differentiation**	**5 hours**
Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials–Statement of vector identities-Simple problems		
Module:7	**Vector Integration**	**5 hours**
line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector integrals using them.		
Module:8	**Contemporary Issues:**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**

Text Book(s)

[1] Thomas' Calculus, George B.Thomas, D.Weir and J. Hass, 13th edition, Pearson, 2014.
[2] Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India, 2015.

Reference Books

1. Higher Engineering Mathematics, B.S. Grewal, 43rd Edition ,Khanna Publishers, 2015
2. Higher Engineering Mathematics, John Bird, 6th Edition, Elsevier Limited, 2017.
3. Calculus: Early Transcendentals, James Stewart, 8th edition, Cengage Learning, 2017.
4. Engineering Mathematics, K.A.Stroud and Dexter J. Booth, 7th Edition, Palgrave Macmillan (2013)

Mode of Evaluation

Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test

List of Challenging Experiments (Indicative)		
1.	Introduction to MATLAB through matrices, and general Syntax	3 hours
2	Plotting and visualizing curves and surfaces in MATLAB –	3 hours

	Symbolic computations using MATLAB	
3.	Evaluating Extremum of a single variable function	3 hours
4.	Understanding integration as Area under the curve	3 hours
5.	Evaluation of Volume by Integrals (Solids of Revolution)	3 hours
6.	Evaluating maxima and minima of functions of several variables	3 hours
7.	Applying Lagrange multiplier optimization method	2 hours
8.	Evaluating Volume under surfaces	2 hours
9.	Evaluating triple integrals	2 hours
10.	Evaluating gradient, curl and divergence	2 hours
11.	Evaluating line integrals in vectors	2 hours
12.	Applying Green's theorem to real world problems	2 hours
	Total Laboratory Hours	**30 hours**

Mode of Assessment:			
Weekly assessment, Final Assessment Test			
Recommended by Board of Studies	12-06-2015		
Approved by Academic Council	No. 37	Date	16-06-2015

MAT2001	Statistics for Engineers	L	T	P	J	C
		3	0	2	0	4
Prerequisites	**MAT1011 – Calculus for Engineers**	**Syllabus Version**: 1.1				

Course Objectives :

1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations.
2. To analyse distributions and relationship of real-time data.
3. To apply estimation and testing methods to make inference and modelling techniques for decision making.

Expected Course Outcome:

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

1. Compute and interpret descriptive statistics using numerical and graphical techniques.
2. Understand the basic concepts of random variables and find an appropriate distribution for analysing data specific to an experiment.
3. Apply statistical methods like correlation, regression analysis in analysing, interpreting experimental data.
4. Make appropriate decisions using statistical inference that is the central to experimental research.
5. Use statistical methodology and tools in reliability engineering problems.
6. demonstrate R programming for statistical data

Student Learning Outcome (SLO):	**1, 2, 7, 9, 14**

Module: 1	**Introduction to Statistics**	**6 hours**

Introduction to statistics and data analysis-Measures of central tendency –Measures of variability-[Moments-Skewness-Kurtosis (Concepts only)].

Module: 2	**Random variables**	**8 hours**

Introduction -random variables-Probability mass Function, distribution and density functions - joint Probability distribution and joint density functions- Marginal, conditional distribution and density functions- Mathematical expectation, and its properties Covariance , moment generating function – characteristic function.

Module: 3	**Correlation and regression**	**4 hours**

Correlation and Regression – Rank Correlation- Partial and Multiple correlation- Multiple regression.

Module: 4	**Probability Distributions**	**7 hours**

Binomial and Poisson distributions – Normal distribution – Gamma distribution –

Exponential distribution – Weibull distribution.		
Module: 5	**Hypothesis Testing I**	**4 hours**
Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis-Large sample tests- Z test for Single Proportion, Difference of Proportion, mean and difference of means.		
Module: 6	**Hypothesis Testing II**	**9 hours**
Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – one and two way classifications - CRD-RBD- LSD.		
Module: 7	**Reliability**	**5 hours**
Basic concepts- Hazard function-Reliabilities of series and parallel systems- System Reliability - Maintainability-Preventive and repair maintenance- Availability.		
Module: 8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours	**45 hours**

Text book(s)

- Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
- Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons (2016).

Reference books

- Reliability Engineering, E.Balagurusamy, Tata McGraw Hill, Tenth reprint 2017.
- Probability and Statistics, J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012).
- Probability and Statistics for Engineers, R.A.Johnson, Miller Freund's, 8th edition, Prentice Hall India (2011).
- Probability, Statistics and Reliability for Engineers and Scientists, Bilal M. Ayyub and Richard H. McCuen, 3rd edition, CRC press (2011).

Mode of Evaluation

Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test.

List of Experiments (Indicative)		
•	Introduction: Understanding Data types; importing/exporting data.	3 hours
•	Computing Summary Statistics /plotting and visualizing	3 hours

	data using Tabulation and Graphical Representations.	
•	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination.	3hours
•	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficient of determination.	3 hours
•	Fitting the following probability distributions: Binomial distribution	3 hours
•	Normal distribution, Poisson distribution	3 hours
•	Testing of hypothesis for One sample mean and proportion from real-time problems.	3 hours
	Testing of hypothesis for Two sample means and proportion from real-time problems	3 hours
•	Applying the t test for independent and dependent samples	2 hours
•	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	2 hours
•	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design ,Latin square Design	2 hours
	Total laboratory hours	**30 hours**

Mode of Evaluation			
Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	25-02-2017		
Approved by Academic Council	47	Date:	05-10-2017

MGT1022	LEAN START-UP MANAGEMENT	L	T	P	J	C
		1	0	0	4	2
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

To develop the ability to

1. Learn methods of company formation and management.
2. Gain practical skills in and experience of stating of business using pre-set collection of business ideas.
3. Learn basics of entrepreneurial skills.

Expected Course Outcome:

On completion of this course the students will be able to:

1. Understand developing business models and growth drivers
2. Use the business model canvas to map out key components of enterprise
3. Analyze market size, cost structure, revenue streams, and value chain
4. Understand build-measure-learn principles
5. Foreseeing and quantifying business and financial risks

Student Learning Outcomes (SLO):	2, 4, 18, 19

Module: 1	**2hours**

Creativity and Design Thinking (identify the vertical for business opportunity, understand your customers, accurately assess market opportunity)

Module: 2	**3 hours**

Minimum Viable Product (Value Proposition, Customer Segments, Build-measure-learn process)

Module: 3	**3hours**

Business Model Development (Channels and Partners, Revenue Model and streams, Key Resources, Activities and Costs, Customer Relationships and Customer Development Processes, Business model canvas–the lean model-templates)

Module: 4	**3 hours**

Business Plan and Access to Funding (visioning your venture, taking the product / service to market, Market plan including Digital & Viral Marketing, start-up finance – Costs / Profits & Losses / cash flow, Angel / VC / Bank Loans and Key elements of raising money)

Module: 5	**2hours**

Legal, Regulatory, CSR, Standards,Taxes

Module: 6	**2 hours**

Lectures by Entrepreneurs

Total Lecture hours	**15 hours**

Text Book (s)

1.	Steve Blank, K & S Ranch (2012)The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, 1st edition
2.	Steve Blank (2013) The Four Steps to the Epiphany, K&S Ranch; 2nd edition
3.	Eric Ries (2011) The Lean Startup: How Today's Entrepreneurs Use Continuous

	Innovation to Create Radically Successful Businesses, Crown Business			
Reference Books				
1.	Holding a Cat by the Tail, Steve Blank, K & S Ranch Publishing LLC (August 14, 2014)			
2.	Product Design and Development, Karal TUlrich, SDEppinger, McGrawHill			
3.	Zero to One: Notes on Startups, or How to Build the Future, Peter Thiel, Crown Business (2014)			
4.	Lean Analytics: Use Data to Build a Better Startup Faster (Lean Series), Alistair Croll & Benjamin Yoskovitz, O' Reilly Media; 1st Edition (March 21, 2013)			
5.	Inspired: How to create Products Customers Love, Marty Cagan,S VPG Press; 1st edition (June18, 2008)			
6.	**Website References:** 1. http://theleanstartup.com/ 2. https://www.kickstarter.com/projects/881308232/only-on-kickstarter-the-leaders-guide-by-eric-ries 3. http://businessmodelgeneration.com/ 4. https://www.leanstartupmachine.com/ 5. https://www.youtube.com/watch?v=fEvKo90qBns 6. http://thenextweb.com/entrepreneur/2015/07/05/whats-wrong-with-the-lean-startup-methodology/#gref 7. http://www.businessinsider.in/Whats-Lean-about-Lean-Startup/articleshow/53615661.cms 8. https://steveblank.com/tools-and-blogs-for-entrepreneurs/ 9. https://hbr.org/2013/05/why-the-lean-start-up-changes-everything 10. chventures.blogspot.in/platformsandnetworks.blogspot.in/p/saas-model.html			
Teaching Modes: Assignments; Field Trips, Case Studies; e-learning; Learning through research, TED Talks				
Project				
1.	Project	60 hours		
Total Project		**60 hours**		
Recommended by Board of Studies		08.06.2015		
Approved by Academic Council		37th ACM	**Date**	16.06.2015

PHY1701	Engineering Physics	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Physics of 12th standard or equivalent**	**Syllabus version**				
		1.0				

Course Objectives:

To enable the students to understand the basics of the latest advancements in Physics viz., Quantum Mechanics,
Nanotechnology, Lasers, Electro Magnetic Theory and Fiber Optics.

Expected Course Outcome: : Students will be able to

1. Comprehend the dual nature of radiation and matter.
2. Compute Schrodinger's equations to solve finite and infinite potential problems.
3. Analyze quantum ideas at the nanoscale.
4. Apply quantum ideas for understanding the operation and working principle of optoelectronic devices.
5. Recall the Maxwell's equations in differential and integral form.
6. Design the various types of optical fibers for different Engineering applications.
7. Apply the various types of optoelectronic devices for designing a typical optical fiber communication system.
8. Demonstrate the quantum mechanical ideas

Student Learning Outcomes (SLO): 2, 4, 5, 9

Module:1	**Introduction to Modern Physics**	**6 hours**

Planck's concept (hypothesis), Compton Effect, Particle properties of wave: Matter Waves, Davisson Germer Experiment, Heisenberg Uncertainty Principle, Wave function, and Schrodinger equation (time dependent & independent).

Module:2	**Applications of Quantum Physics**	**6 hours**

Particle in a 1-D box (Eigen Value and Eigen Function), 3-D Analysis (Qualitative), Tunneling Effect (Qualitative), Scanning Tunneling Microscope (STM).

Module:3	**Nanophysics**	**6 hours**

Introduction to Nano-materials, Moore's law, Properties of Nano-materials, Types of Nano-materials, Synthesis of Nano-materials (Top-down and Bottom-up approaches), Quantum confinement, Quantum well, wire & dot, Fullerenes, Carbon Nano-tubes (CNT), Applications of nanotechnology in industry.

Module:4	**Laser Principles and Engineering Application**	**7 hours**

Laser Characteristics, Spatial and Temporal Coherence, Einstein Coefficient & its significance, Population inversion, Two, three & four level systems, Pumping schemes, Threshold gain coefficient, Components of laser, Nd-YAG, He-Ne, CO_2 and their engineering applications.

Module:5	**Electromagnetic Theory and its application**	**6 hours**

Physics of Divergence, Gradient and Curl, Qualitative understanding of surface and volume integral, Maxwell Equations (Qualitative), Wave Equation (Derivation), EM Waves, Phase velocity, Group velocity, Group index (Qualitative), experimental evidence of light as em wave (Hertz experiment)

Module:6	**Propagation of EM waves in Optical fibers**	**6 hours**

Light propagation through fibers, Acceptance angle, Numerical Aperture, Types of fibers - step index, graded index, single mode & multimode, Attenuation, Dispersion-intermodal and intramodal.

Module:7	**Optoelectronic Devices & Applications of Optical fibers**	**6 hours**

Introduction to semiconductors, Direct and indirect bandgap, Sources-LED & Laser Diode, Detectors-Photodetectors- PN & PIN - Applications of fiber optics in communication- Endoscopy.		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Arthur Beiser et al., Concepts of Modern Physics, 2013, Sixth Edition, Tata McGraw Hill.
2. William Silfvast, Laser Fundamentals, 2008, Cambridge University Press.
3. D. J. Griffith, Introduction to Electrodynamics, 2014, 4th Edition, Pearson.
4. Djafar K. Mynbaev and Lowell L.Scheiner, Fiber Optic Communication Technology, 2011, Pearson

Reference Books

1. Raymond A. Serway, Clement J. Mosses, Curt A. Moyer Modern Physics, 2010, 3rd Indian Edition Cengage learning.
2. John R. Taylor, Chris D. Zafiratos and Michael A. Dubson, Modern Physics for Scientists and Engineers, 2011, PHI Learning Private Ltd.
3. Kenneth Krane, Modern Physics, 2010, Wiley Indian Edition.
4. Nityanand Choudhary and Richa Verma, Laser Systems and Applications, 2011, PHI Learning Private Ltd.
5. S. Nagabhushana and B. Sathyanarayana, Lasers and Optical Instrumentation, 2010, I.K. International Publishing House Pvt. Ltd.,
6. R. Shevgaonkar, Electromagnetic Waves, 2017, Tata McGraw Hill.Matthew N.O. Sadiku, Principles of Electromagnetics, 2010, Fourth Edition, Oxford.
7. Ajoy Ghatak and K. Thyagarajan, Introduction to Fiber Optics, 2010, Cambridge University Press.
8. S.M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, 2008, 3rd Edition, Wiley.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Experiments

1.	Determination of Planck's constant using electroluminescence process	2 hrs
2.	Electron diffraction	2 hrs
3.	Determination of wavelength of laser source (He -Ne laser and diode lasers of different wavelengths) using diffraction technique	2 hrs
4.	Determination of size of fine particle using laser diffraction	2 hrs
5.	Determination of the track width (periodicity) in a written CD	2 hrs
6.	Optical Fiber communication (source + optical fiber + detector)	2 hrs
7.	Analysis of crystallite size and strain in a nano -crystalline film using X-ray diffraction	2 hrs
8.	Numerical solutions of Schrödinger equation (e.g. particle in a box problem) (can be given as an assignment)	2 hrs
9.	Laser coherence length measurement	2 hrs
10.	Proof for transverse nature of E.M. waves	2 hrs
11.	Quantum confinement and Heisenberg's uncertainty principle	2 hrs
12.	Determination of angle of prism and refractive index for various colour – Spectrometer	2 hrs

13.	Determination of divergence of a laser beam	2 hrs
14.	Determination of crystalline size for nanomaterial (Computer simulation)	2 hrs
15.	Demonstration of phase velocity and group velocity (Computer simulation)	2 hrs
	Total Laboratory Hours	**30 hrs**

Mode of evaluation: CAT / FAT			
Recommended by Board of Studies	25.06.2020		
Approved by Academic Council	No. 59	Date	24-09-2020

PHY1901	Introduction to Innovative Projects	L	T	P	J	C
		1	0	0	0	1
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

This course is offered to the students in the 1st Year of B. Tech. in order to orient them towards independent, systemic thinking and be innovative.

1. To make students confident enough to handle the day to day issues.
2. To develop the "Thinking Skill" of the students, especially Creative Thinking Skills
3. To train the students to be innovative in all their activities
4. To prepare a project report on a socially relevant theme as a solution to the existing issues

Course Outcome:

1. To understand the various types of thinking skills.
2. To enhance the innovative and creative ideas.
3. To find out a suitable solution for socially relevant issues-J component

Module:1A	Self Confidence	1hour

Understanding self– JohariWindow–SWOTAnalysis– Self Esteem– Being a contributor – Case Study

Project : Exploring self, understanding surrounding,thinking about how s(he) can be a contributor

For the society, Creating a big picture of being an innovator–writing a1000words imaginary Autobiographyof self–Topic"Mr. X–the great innovatorof2015" and upload.

(non-contact hours)

Module:1B	Thinking Skill	1 hour

Thinking and Behaviour–Typesofthinking–Concrete– Abstract, Convergent, Divergent,Creative, Analytical, Sequentialand Holistic thinking–ChunkingTriangle–Context Grid – Examples – Case Study.

Project: Meeting atleast 50 people belonging to various strata of life and talk to them / make field visits to identify amin. of100societyrelated issues, problemsforwhich theyneed solutionsand categories them and upload alongwith details of people met and lessonslearnt.**(4 non-contact hours)**

Module: 1C	Lateral Thinking Skill	1 hour

BloomsTaxonomy–HOTS–Out of the box thinking–deBono lateral thinking model–Examples

Project : Last weeks-incomplete portion to be done and uploaded

Module:2A	Creativity	1 hour

Creativity Models–Walla–Barrons–Koberg & Begnall–Examples

Project: Selecting5outof 100issuesidentifiedforfuturework. Criteria basedapproach for prioritisation, use of statistical tools& upload. **(4 non-contact hours)**

Module:2B	Brainstorming	1 hour

25 brainstorming techniquesand examples

Project: Brain storm and come out with as many solutions as possible for the top 5 issues identified & upload. **(4 non-contact hours)**

Module:3	MindMapping	1 hour

Mind Mappingtechniquesandguidelines. Drawing amind map

Project: UsingMindMapsgetanothersetof solutionsforthe next 5 issues(issue6–10).

(4 non-contact hours)

Module:4A	Systemsthinking	1 hour

SystemsThinkingessentials–examples–CounterIntuitive condemns

Project: Select 1 issue / problem for which the possible solutions are available with you. Apply Systems Thinking process and pickup one solution[explanation should be given why the other

possible solutions have been left out].Go back to the customer and assess the acceptability and upload. **(4 non-contact hours)**		
Module:4B	**DesignThinking**	**1 hour**
Designthinkingprocess–Humanelementofdesign thinking– casestudy **Project:** Apply design thinking to the selected solution; apply the engineering & scientific tinge to it. Participate in "design week" celebrations upload the weeks learning outcome.		
Module:5A	**Innovation**	**1 hour**
DifferencebetweenCreativityandInnovation–Examples ofinnovation–Being innovative. **Project:** A literature searches on proto typing of your solution finalized. Prepare a proto type model or process and upload.**(4 non-contact hours)**		
Module:5B	**BlocksforInnovation**	**1 hour**
IdentifyBlocksforcreativityandinnovation – overcomingobstacles – Case Study **Project:** Project presentation on problem identification,solution,innovations-expectedresults–InterimreviewwithPPTpresentation. **(4 non-contact hours)**		
Module:5C	**InnovationProcess**	**1 hour**
StepsforInnovation–rightclimateforinnovation **Project:** Refiningtheproject,basedonthereviewreportanduploading the text. **(4 non-contact hours)**		
Module:6A	**Innovation in India**	**1 hour**
Storiesof10 Indian innovations **Project:** Makingthe project better with add ons.**(4 non- contact hours)**		
Module:6B	**JUGAAD Innovation**	**1 hour**
Frugal and flexible approach toinnovation-doing more with less Indian Examples **Project:** FinetuningtheinnovationprojectwithJUGAADprinciplesand uploading (Credit for JUGAADimplementation).**(4 non-contact hours)**		
Module:7A	**Innovation Project Proposal Presentation**	**1 hour**
Projectproposal contents, economic input, ROI–Template **Project:** Presentationoftheinnovativeprojectproposalandupload.**(4 non- contact hours)**		
Module:8A	**Contemporary issuein Innovation**	**1 hour**
Contemporary issuein Innovation **Project:** Final project Presentation, Viva voce Exam (**4 non-contact hours)**		
Total Lecture hours		**15 hours**
Text Book(s)		
1.	How to have Creative Ideas, Edward debone,Vermilon publication, UK, 2007	
2.	The Artof Innovation, Tom Kelley &Jonathan Littman, ProfileBooks Ltd., UK, 2008	
Reference Books		
1.	Creating Confidence, MeribethBonct, KoganPage India Ltd., New Delhi, 2000	
2.	Lateral Thinking Skills, Paul Sloane, KeoganPage India Ltd, NewDelhi, 2008	
3.	Indian Innovators, AkhatAgrawal, JaicoBooks, Mumbai,2015	
4.	JUGAAD Innovation, NaviRadjou, JaideepPrabhu, Simone Ahuja Random house India, Noida, 2012.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar Threereviewswith weightageof25 :25 : 50 alongwithreports		
Recommended by Board of Studies		
Approved by Academic Council	53	**Date** 13.12.2018

VELLORE INSTITUTE OF TECHNOLOGY (Deemed to be University under section 3 of UGC Act, 1956) OFFICE OF THE DEAN (ACADEMICS) Vellore-632014, Tamil Nadu, India

CHY1002	Environmental Sciences	L	T	P	J	C
		3	0	0	0	3
Pre-requisite		**Syllabus version**				
		1.1				

Course Objectives:

1. To make students understand and appreciate the unity of life in all its forms, the implications of life style on the environment.
2. To understand the various causes for environmental degradation.
3. To understand individuals contribution in the environmental pollution.
4. To understand the impact of pollution at the global level and also in the local environment.

Expected Course Outcome: Students will be able to

1. Students will **recognize** the environmental issues in a problem oriented interdisciplinary perspectives
2. Students will **understand** the key environmental issues, the science behind those problems and potential solutions.
3. Students will **demonstrate** the significance of biodiversity and its preservation
4. Students will **identify** various environmental hazards
5. Students will **design** various methods for the conservation of resources
6. Students will **formulate** action plans for sustainable alternatives that incorporate science, humanity, and social aspects
7. Students will have foundational **knowledge** enabling them to make sound life decisions as well as enter a career in an environmental profession or higher education.

Student Learning Outcomes (SLO):	1,2,3,4,5,9,11,12

Module:1	**Environment and Ecosystem**	**7 hours**

Key environmental problems, their basic causes and sustainable solutions. IPAT equation. Ecosystem, earth – life support system and ecosystem components; Food chain, food web, Energy flow in ecosystem; Ecological succession- stages involved, Primary and secondary succession, Hydrarch, mesarch, xerarch; Nutrient, water, carbon, nitrogen, cycles; Effect of human activities on these cycles.

Module:2	**Biodiversity**	**6 hours**

Importance, types, mega-biodiversity; Species interaction - Extinct, endemic, endangered and rare species; Hot-spots; GM crops- Advantages and disadvantages; Terrestrial biodiversity and Aquatic biodiversity – Significance, Threats due to natural and anthropogenic activities and Conservation methods.

Module:3	**Sustaining Natural Resources and Environmental Quality**	**7 hours**

Environmental hazards – causes and solutions. Biological hazards – AIDS, Malaria, Chemical hazards- BPA, PCB, Phthalates, Mercury, Nuclear hazards- Risk and evaluation of hazards. Water footprint; virtual water, blue revolution. Water quality management and its conservation. Solid and hazardous waste – types and waste management methods.

Module:4	**Energy Resources**	**6 hours**
Renewable - Non renewable energy resources- Advantages and disadvantages - oil, Natural gas, Coal, Nuclear energy. Energy efficiency and renewable energy. Solar energy, Hydroelectric power, Ocean thermal energy, Wind and geothermal energy. Energy from biomass, solar- Hydrogen revolution.		
Module:5	**Environmental Impact Assessment**	**6 hours**
Introduction to environmental impact analysis. EIA guidelines, Notification of Government of India (Environmental Protection Act – Air, water, forest and wild life). Impact assessment methodologies. Public awareness. Environmental priorities in India.		
Module:6	**Human Population Change and Environment**	**6 hours**
Urban environmental problems; Consumerism and waste products; Promotion of economic development – Impact of population age structure – Women and child welfare, Women empowerment. Sustaining human societies: Economics, environment, policies and education.		
Module:7	**Global Climatic Change and Mitigation**	**5 hours**
Climate disruption, Green house effect, Ozone layer depletion and Acid rain. Kyoto protocol, Carbon credits, Carbon sequestration methods and Montreal Protocol. Role of Information technology in environment-Case Studies.		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**

Text Books

1. G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengage learning.
2. George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.

Reference Books

1. David M.Hassenzahl, Mary Catherine Hager, Linda R.Berg (2011), Visualizing Environmental Science, 4thEdition, John Wiley & Sons, USA.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT

Recommended by Board of Studies	12.08.2017		
Approved by Academic Council	No. 46	Date	24.08.2017