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

(2019-2020)

B. Tech. Computer Science and Engineering and Business Systems

(in collaboration with TCS)

School of Computer Science and Engineering

B. Tech. Computer Science and Engineering and Business Systems
(in collaboration with TCS)

CURRICULUM AND SYLLABI

(2019-2020 Admitted Students)

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Index

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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.

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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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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.
- Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.
- Graduates will function in their profession with social awareness and responsibility.
- Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.
- Graduates will be successful in pursuing higher studies in engineering or management.
- Graduates will pursue career paths in teaching or research.

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PROGRAMME OUTCOMES (POs)

- **PO_01:** Having an ability to apply mathematics and science in engineering applications.
- **PO_02:** Having a clear understanding of the subject related concepts and of contemporary issues.
- **PO_03:** Having an ability to design a component or a product applying all the relevant standards and with realistic constraints.
- **PO_04:** Having an ability to design and conduct experiments, as well as to analyze and interpret data.
- **PO_05:** Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice.
- **PO_06:** Having problem solving ability-solving social issues and engineering problems.
- **PO_07:** Having adaptive thinking and adaptability.
- **PO_08:** Having a clear understanding of professional and ethical

responsibility.

- **PO_09:** 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)

- The ability to apply theoretical foundations of Computer Science and problem-solving skills through programming techniques for complex real time problems using appropriate data structures and algorithms.
- The ability to design/develop hardware and software interfaces along with database management to meet the needs of industry.
- The ability to demonstrate personal, organizational and entrepreneurship skills through critical thinking, engage themselves in life-long learning by following innovations in business, science & technology.

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CREDIT STRUCTURE

Category Wise Credit Distribution

Category	*Credits*
Programme Core (PC)	72
Programme Elective (PE)	30
University Core (UC)	52
University Elective (UE)	6
Bridge Course (BC)	-
Non-Credit Course	-
Total Credits	**160**

Programme Core	Programme Elective	University Core	University Elective	Total Credits
72	30	52	6	160

Course Code	Course Title	Course Type	L	T	P	J	C
PROGRAMME CORE							
CBS1003	Data Structures and Algorithms	ETL	2	0	2	0	3
CBS1004	Computer Architecture and Organization	ETL	2	0	2	0	3
CBS1005	Software Engineering Methodologies	ETL	2	0	2	0	3
CBS1006	Principles of Operating Systems	ETL	2	0	2	0	3
CBS1007	Database Systems	ETL	2	0	2	0	3
CBS1008	Operations Research	ETL	2	0	2	0	3
CBS1009	Computational Statistics	ETL	2	0	2	0	3
CBS2002	Formal Languages and Automata Theory	TH	3	0	0	0	3
CBS2003	Design Thinking	ETL	2	0	2	0	3
CBS3001	Computer Networks	ETL	2	0	2	0	3
CBS3002	Information Security	ETL	2	0	2	0	3
CBS3003	Design and Analysis of Algorithms	ETL	2	0	2	0	3
CBS3004	Artificial Intelligence	ETL	2	0	2	0	3
CBS3011	Usability Design of Software Applications	ETL	2	0	2	0	3
CBS3012	IT Project Management	ETL	2	0	2	0	3
EEE1001	Basic Electrical and Electronics Engineering	ETL	2	0	2	0	3
MAT1004	Discrete Mathematics	TH	3	0	0	0	3
MAT2004	Linear Algebra	TH	3	1	0	0	4
MAT2005	Data Science and Statistical Modelling	ETL	2	0	2	0	3
MGT1064	Financial and Cost Accounting	TH	3	0	0	0	3
MGT1065	Fundamentals of Management	TH	2	0	0	0	2
MGT2002	Marketing Research and Marketing Management	TH	3	0	0	0	3
MGT2003	Financial Management	TH	3	0	0	0	3
MGT3016	Services Science and Service Operational Management	ETL	2	0	2	0	3
Course Code	**Course Title**	**Course Type**	**L**	**T**	**P**	**J**	**C**
PROGRAMME ELECTIVE							
CBS3005	Cloud, Microservices and Applications	ETL	3	0	2	0	4
CBS3006	Machine Learning	ETLP	2	0	2	4	4
CBS3007	Data Mining and Analytics	ETL	3	0	2	0	4
CBS3008	Introduction to Internet of Things	ETL	3	0	2	0	4
CBS3009	Advanced Social, Text and Media Analytics	TH	3	0	0	0	3

Course Code	Course Title	Course Type	L	T	P	J	C
CBS3010	Mobile Computing	ETL	3	0	2	0	4
CBS3013	Conversational Systems	ETL	3	0	2	0	4
CBS3014	Modern Web Applications	ETL	3	0	2	0	4
CBS3015	Information Systems Audit and Control	TH	3	0	0	0	3
CBS3016	Cognitive Science and Analytics	ETL	3	0	2	0	4
CBS4001	Robotics and Embedded Systems	ETL	3	0	2	0	4
CBS4002	Cryptology and Analysis	TH	3	0	0	0	3
CBS4003	Quantum Computation and Quantum Information	ETL	3	0	2	0	4
CBS4004	Image Processing and Pattern Recognition	ETP	3	0	0	4	4
CBS4005	Enterprise Systems	ETL	3	0	2	0	4
HUM1046	Behavioral Economics	TH	3	0	0	0	3
HUM1047	Engineering Economics	TH	3	0	0	0	3
HUM1048	Industrial Psychology	TH	3	0	0	0	3
MGT3001	Business Strategy	TH	3	0	0	0	3
MGT3002	Advanced Finance	TH	3	0	0	0	3
MGT4004	Human Resource Management	TH	3	0	0	0	3
MGT4005	Computational Finance and Modelling	ETL	3	0	2	0	4
Course Code	**Course Title**	**Course Type**	**L**	**T**	**P**	**J**	**C**
	UNIVERSITY CORE						
CBS1002	Object Oriented Programming	ETL	3	0	2	0	4
CBS1901	Technical Answers for Real World Problems (TARP)	ETP	1	0	0	4	2
CBS1902	Industrial Project	PJT	0	0	0	0	1
CBS1903	Comprehensive Examination	PJT	0	0	0	0	1
CBS1904	Capstone Project	PJT	0	0	0	0	12
CHY1701	Engineering Chemistry	ETL	3	0	2	0	4
CSE1008	Programming in C	ETL	3	0	2	0	4
ENG1013	Business Communication and Value Science - I	ETL	1	0	2	0	2
ENG1014	Business Communication and Value Science - II	ETL	1	0	2	0	2
ENG1017	Business Communication and Value Science - III	ETL	1	0	2	0	2
ENG1018	Business Communication and Value Science - IV	ETL	1	0	2	0	2
ENG1901	Technical English - I	LO	0	0	4	0	2
ENG1902	Technical English - II	LO	0	0	4	0	2
ENG1903	Advanced Technical English	ELP	0	0	2	4	2
HUM1021	Ethics and Values	TH	2	0	0	0	2

Course Code	Course Title	Course Type	L	T	P	J	C
MAT1017	Probability and Statistics	TH	3	0	0	0	3
MGT2001	Introduction to Innovation, IP Management and Entrepreneurship	TH	3	0	0	0	3
PHY1005	Modern Physics	ETL	3	0	2	0	4
FLC4097	Foreign Language Course Basket	CDB	0	0	0	0	2
ESP1001 - ESPANOL FUNDAMENTAL – TH							
ESP2001 - ESPANOL INTERMEDIO – ETL							
FRE2001 - Francais progressif – ETL							
GER1001 - Grundstufe Deutsch – TH							
GER2001 - Mittelstufe Deutsch – ETL							
GRE1001 - Modern Greek – TH							
JAP1001 - Japanese for Beginners – TH							
RUS1001 - Russian for Beginners – TH							

Course Code	Course Title	Course Type	L	T	P	J	C
BRIDGE COURSE							

Course Code	Course Title	Course Type	L	T	P	J	C
NON-CREDIT COURSES							
CHY1002	Environmental Sciences	TH	3	0	0	0	3
ENG1000	Foundation English - I	LO	0	0	4	0	2
ENG2000	Foundation English - II	LO	0	0	4	0	2
EXC4097	Co-Extra Curricular Basket	CDB	0	0	0	0	2

PROGRAMME CORE

(2019 - 2020)

B. Tech. Computer Science and Engineering and Business Systems

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Course Code	Course Title	L	T	P	J	C
CBS1003	Data Structures and Algorithms	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To analyze the asymptotic performance of algorithms.
2. To explore the linear and non-linear data structures and their applications.
3. To Perform searching and sorting using various techniques and Graphs.

Expected Course Outcome:

After completion of this course, students will be able to:

1. Realize the basic terminologies in data structures.
2. Idealize the features of linear data structures and their applications.
3. Demonstrate various types of nonlinear data structures and their applications in real world.
4. Choose appropriate sorting and searching technique for the given problem.
5. Organize data using files and understand various access methods
6. Provide efficient algorithmic solution and data structures to real-world problems.

Module:1	Introduction to Algorithm & Data Organization	3 hours

Algorithm specification, Recursion, Performance analysis, Asymptotic Notation - The Big-O, Omega and Theta notation, Programming Style, Refinement of Coding - Time-Space Trade Off, Testing, Data Abstraction

Module:2	Linear Data Structures	4 hours

Array, Stack, Queue, Linked-list and its types, Various Representations, Operations & Applications of Linear Data Structures.

Module:3	Basic Non-Linear Data Structures	5 hours

Trees (Binary Tree, Threaded Binary Tree, Binary Search Tree, B & B+ Tree, AVL Tree, Splay Tree).

Module:4	Advanced Non-Linear Data Structures	5 hours

Graphs (Directed, Undirected), Various Representations, Operations (search and traversal algorithms and complexity analysis) & Applications of Non-Linear Data Structures

Module:5	Searching And Sorting On Data Structures	5 hours

Sequential Search, Binary Search, Comparison Trees, Breadth First Search, Depth First Search, Insertion Sort, Selection Sort, Shell Sort, Divide and Conquer Sort, Merge Sort, Quick Sort, Heap Sort, Introduction to Hashing

Module:6	File Organization	3 hours

Organization (Sequential, Direct, Indexed Sequential, Hashed) and various types of accessing schemes.

Module:7	Graphs	3 hours

Basic Terminologies and Representations, Graph search and traversal algorithms andcomplexity analysis.

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

Lab Experiments		
1.	Towers of Hanoi using user defined stacks.	6 Hours
2.	Reading, writing, and addition of polynomials.	3 Hours
3.	Line editors with line count, word count showing on the screen.	3 Hours
4.	Trees with all operations.	6 Hours
5.	Graph algorithms.	6 Hours
6.	Saving / retrieving non-linear data structure in/from a file	6 Hours
	Total Hours	**30 hours**

Text Book(s)	
1.	E Horowitz and S Sahni, "Fundamentals of Data Structures", Second Edition, Galgotia Booksource, 2008.
2.	Alfred V. Aho, John E. Hopperoft, Jeffrey D. UIlman, "Data Structures and Algorithms", First Edition, Pearson Publishers, 1983.
Reference Books	
1.	Knuth Donald E, "Art of Computer Programming: Fundamental Algorithms Volume 1 Fundamental Algorithms", Third Edition, Pearson Publishers, 2011.
2	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, PHI Publishers, 2009.
3	Pat Morin, Open Data Structures: An Introduction (Open Paths to Enriched Learning), 31st ed. Edition, UBC Press, 2013.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**16-02-2019**		
Approved by Academic Council	**No. 55**	**Date**	**13-06-2019**

Course Code	Course Title	L	T	P	J	C
CBS1004	Computer Architecture and Organization	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To provide knowledge on overview of IAS computer function and addressingmodes.
2. Hardware and software implementation of arithmetic unit to solve addition, subtraction, multiplication and division.
3. To provide knowledge of memory technologies, interfacing techniques and sub system devices.

Expected Course Outcome:

1. Provide fundamentals on machine instructions and addressing modes.
2. Comprehend the various algorithms for computer arithmetic.
3. Analyse the performance of various memory modules in memory hierarchy.
4. Compare and contrast the features of I/O devices and parallel processors.
5. Outline the evaluation of memory organization.
6. Analyse the performance of Arithmetic logic unit, memory and CPU.

Module:1	Introduction to Computer Architecture	4 hours

Functional blocks of a computer: CPU, memory, input-output subsystems, control unit.
Instruction set architecture of a CPU**:** Registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Outlining instruction sets of some common CPUs.

Module:2	Data representation	3 hours

Signed number representation, fixed and floating-point representations, character representation.

Module:3	Computer arithmetic	5 hours

Integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and-add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic, IEEE 754 format.

Module:4	CPU control unit design	4 hours

Hardwired and micro-programmed design approaches, design of a simple hypothetical CPU.
Memory system design: Semiconductor memory technologies, memory organization.

Module:5	Peripheral devices and their characteristics	6 hours

Input-output subsystems, I/O device interface, I/O transfers – program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes – role of interrupts in process state transitions, I/O device interfaces – SCII, USB.

Module:6	Pipelining	4 hours

Basic concepts of pipelining, throughput and speedup, pipeline hazards. Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.

Module:7	**Memory organization**	**3 hours**
Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.		
Module:8	**Contemporary issues**	**1 hour**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	M. M. Mano, Computer System Architecture, 3rd ed., Prentice Hall of India, 1993.
2.	David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 4th Edition, Elsevier, 2012.
3.	Carl Hamacher, ZvonkoVranesic, SafwatZaky, NaraigManjikian, Computer Organization and Embedded Systems, McGraw-Hill Publishing, 2011
Reference Books	
1.	John P. Hayes, Computer Architecture and Organization, McGraw-Hill, 1998
2.	William Stallings, Computer Organization and Architecture: Designing for Performance, 8th Edition, Prentice Hall, 2006.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	Arithmetic Logic Unit	7 hours
2.	Memory Design	7 hours
3.	CPU Design	8 hours
4.	Combinational Multipliers	8 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**16-02-2019**		
Approved by Academic Council	**No.55**	**Date**	**13-06-2019**

Course Code	Course Title	L	T	P	J	C
CBS1005	Software Engineering Methodologies	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To introduce the fundamental concepts of Software development process.
2. To teach the concepts of system analysis and design for system requirement specification.
3. To introduce the principles of Coding, Testing, documentation and project Management.

Expected Course Outcome:

1. Apply the system development life cycle for any Business system.
2. Establish software project management activities such as planning, scheduling and Estimation for the business system.
3. Specify the business requirements through appropriate system analysis and design.
4. Model the Adapt good programming and documentation standards
5. Implement and demonstrate any business system software from specification to validation and verification.
6. Apply and evaluate the standards in process and in product.

Module:1	Introduction	5 hours

Programming in the small vs. programming in the large; software project failures and importance of software quality and timely availability; engineering approach to software development; role of software engineering towards successful execution of large software projects; emergence of software engineering as a discipline.

Module:2	Software Project Management	5 hours

Basic concepts of life cycle models – different models and milestones; software project planning – identification of activities and resources; concepts of feasibility study; techniques for estimation of schedule and effort; software cost estimation models and concepts of software engineering economics; techniques of software project control and reporting; introduction to measurement of software size; introduction to the concepts of risk and its mitigation; configuration management.

Module:3	Software Quality and Reliability	5 hours

Internal and external qualities; process and product quality; principles to achieve software quality; introduction to different software quality models like McCall, Boehm, FURPS / FURPS+, Dromey, ISO – 9126; introduction to Capability Maturity Models (CMM and CMMI); introduction to software reliability, reliability models and estimation.

Module:3	Software Requirements Analysis, Design and Construction	5 hours

Introduction to Software Requirements Specifications (SRS) and requirement elicitation techniques; techniques for requirement modeling – decision tables, event tables, state transition tables, Petri nets; requirements documentation through use cases; introduction to UML, introduction to software metrics and metrics-based control methods; measures of code and design quality.

Module:4	**Object Oriented Analysis, Design and Construction**	**5 hours**
Concepts - the principles of abstraction, modularity, specification, encapsulation and information hiding; concepts of abstract data type; Class Responsibility Collaborator (CRC) model; quality of design; design measurements; concepts of design patterns; Refactoring; object oriented construction principles; object oriented metrics.		
Module:5	**Software Testing**	**3 hours**
Introduction to faults and failures; basic testing concepts; concepts of verification and validation; black box and white box tests; white box test coverage – code coverage, condition coverage, branch coverage		
Module:6	**Software Evolution**	**3 hours**
Basic concepts of black-box tests – equivalence classes, boundary value tests, usage of state tables; testing use cases; transaction-based testing; testing for non-functional requirements – volume, performance and efficiency; concepts of inspection.		
Module:7	**RECENT TRENDS**	**2 hours**
Recent Trends in Software Design/Testing Related Tools and Standards.		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Roger S. Pressman, Software engineering: a practitioner's approach, Palgrave macmillan, 7th Edition, 2017.
2.	Behforooz, A., and Hudson, F. J. Software engineering fundamentals. Oxford University Press, Inc., 2018.

Reference Books

1.	Sommerville, I. Software Engineering: Pearson New International Edition. Pearson Education Limited, 10th Edition, 2017.
2.	Van Vliet, H., & Van Vliet, J. C. Software engineering: principles and practice, NJ: John Wiley & Sons, 3th Edition, 2008.
3.	IEEE Standards on Software Engineering.

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

List of Indicative Experiments

1.	Understanding the Objective and analysis of problem domain	4 hours
2.	Program analysis tools in the software life cycle	2 hours
3.	Identification of Process Model	2 hours
4.	Identification of requirement and Categorizing the functional and non-functional requirements	4 hours
5.	Software Requirement Specification Requirement	2 hours
6.	Possible design components for the problem domain	2 hours
7.	Function oriented design using SA/SD	2 hours
8.	Object-oriented design using UML	2 hours
9.	Software design specifications	2 hours

10.	User Interface Design	2 hours
11.	Test case design	2 hours
12.	Identification of testing tools for a problem domain	2 hours
13.	Use of appropriate CASE tools and other tools such as configuration management tools	2 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**16-09-2020**		
Approved by Academic Council	**No. 59**	**Date**	**24-09-2020**

Course Code	Course Title	L	T	P	J	C
CBS1006	Principles of Operating Systems	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To introduce the Operating system concepts and designs to provide the skills required to implement the OS services.
2. To describe the trade-offs between contradictory objectives in large scale OS system design.
3. To develop the knowledge for application of the various OS design issues and services.

Expected Course Outcome:

1. Describe the various OS functionalities, structures and layers.
2. Usage of system calls related to OS management and interpreting different stages of various process states.
3. Design CPU scheduling algorithms to meet and validate the scheduling criteria.
4. Apply and explore the communication between inter process and synchronization techniques.
5. Implement memory placement strategies, replacement algorithms related to main memory and virtual memory techniques.
6. Differentiate the file systems; file allocation, access techniques along with virtualization concepts and designing of OS with protection and security enabled capabilities.

Module:1	Introduction to OS and System Structure	3 hours

Introduction: Concept of Operating Systems (OS), Generations of OS, Types of OS, OS Services, Interrupt handling andSystem Calls, Basic architectural concepts of an OS, Concept of Virtual Machine, Resource Manager view, process view and hierarchical view of an OS.

Module:2	Process Management and Scheduling Algorithms	6 hours

Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching. **Process Scheduling**: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time. **Scheduling algorithms**: Pre-emptive and non-pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF.

Module:3	Process Synchronization, Threads and Deadlocks	7 hours

Inter-process Communication: Concurrent processes, precedence graphs,Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Semaphores, Strict Alternation, Peterson's Solution, The Producer / Consumer Problem, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem, Barber's shop problem. **Concurrent Programming:** Critical region, conditional critical region, monitors, concurrent languages, communicating sequential process (CSP); Deadlocks - prevention, avoidance, detection and recovery. **Thread**: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads. **Deadlocks**: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention and Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

Module:4	Memory Management	6 hours

Memory Management: Basic concept, Logical and Physical address maps, Memory allocation: Contiguous Memory allocation – Fixed and variable partition– Internal and External fragmentation and Compaction.**Virtual Memory**: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page allocation, Partitioning, Paging, Page fault, Working Set, Segmentation, Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).		
Module:5	**File Systems Management and Implementation**	**2 hours**
File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.		
Module:6	**I/O and Device Management**	**2 hours**
I/O Hardware: I/O devices, Device controllers, Direct Memory Access, Principles of I/O. **Disk Management**: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.		
Module:7	**Case Study**	**2 hours**
Case study: UNIX OS file system, shell, filters, shell programming, programming with the standard I/O, UNIX system calls.		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Abraham Silberschatz, Peter B. Galvin, Greg Gagne-Operating System Concepts, Wiley, 10th Edition, 2019.
2.	Tanenbaum, Andrew S., and Albert S. Woodhull. Operating systems: design and implementation. Vol. 68. Englewood Cliffs: Prentice Hall, 1997.
Reference Book(s)	
1.	Remzi H. Arpaci-Dusseau, Andrea C. Arpaci-Dusseau, Operating Systems, Three Easy Pieces,Arpaci-Dusseau Books, Inc, 2015.
2.	Dhamdhere, Dhananjay M. Operating systems: a concept-based approach, 2E. Tata McGraw-Hill Education, 2006.
3.	Deitel, Harvey M., Paul J. Deitel, and David R. Choffnes. Operating systems. Delhi. Pearson Education: Dorling Kindersley, 2004.
4.	Milenkovič, Milan. Operating systems: concepts and design. McGraw-Hill, Inc., 1987.

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

List of Indicative 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 assessment: CAT1/CAT2/FAT			
Recommended by Board of Studies	**16-09-2020**		
Approved by Academic Council	**No. 59**	**Date**	**24-09-2020**

Course Code	Course Title	L	T	P	J	C
CBS1007	Database Systems	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To teach and acquaint students the significance of Database design and ER Modelling.
2. To acquaint the students with concepts of good database design and normalization of relational schemas.
3. To teach students the different concurrency control and recovery techniques for transactions.

Expected Course Outcome:

1. Acquire a good understanding of the architecture and functioning of database management systems.
2. Ability to construct an ER model and derive the relational schemas from the model.
3. Analyse and apply the principles and practices of good database design.
4. Use the concepts of data normalization to analyse, measure and evaluate the performance of a database application.
5. Ability to grant and revoke privileges and comprehend database recovery techniques.
6. Construct efficient SQL queries to retrieve and manipulate data as required.

Module:1	Introduction	3 hours

Introduction: Introduction to Database. Hierarchical, Network and Relational Models. Database system architecture: Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML).

Module:2	Data Models	4 hours

Entity-relationship model, network model, relational and object-oriented data models, integrity constraints, data manipulation operations.

Module:3	Relational database design and Query languages	6 hours

Relational database design: Domain and data dependency, Armstrong's axioms, Functional Dependencies, Normal forms, Dependency preservation, Lossless design.

Relational query languages: Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL, ORACLE, DB2, SQL server.

Module:4	Query processing and Optimization	4 hours

Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.

Module:5	Transaction Processing	6 hours

Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp-based schedulers, multi-version and optimistic Concurrency Control schemes, Database recovery.

Module:6	Database Security	4 hours

Storage strategies: Indices, B-trees, Hashing. Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.

Module:7	**Advanced Topics**	**2 hours**
Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.		
Module:8	**Recent Trends**	**1 Hour**
	Total Lecture hours:	**30 hours**

Lab Experiments		
1	Data Definition Language, Data Manipulation Language and Data Control Language commands using SQL	6 hours
2	Create with and without Constraint name	4 hours
3	Relational Algebra – Select, Project, Union, Intersection, Set difference , Join, Cartesian Product	6 hours
4	Normalization	6 hours
5	PL/SQL	4 hours
6	SQL injection	2 hours
7	Object oriented and object relational databases	2 hours
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Silberschatz, A., Korth, H. F., and Sudarshan, S. Database System Concepts, McGraw-Hill, 7th Edition. 2019.
2.	Ponniah, P. Data warehousing fundamentals for IT professionals. John Wiley & Sons, 2nd Edition, 2012.
3.	Berson, A., & Smith, S. J. Data warehousing, data mining, and OLAP. McGraw-Hill, Inc., 2017.
4.	Elmasri, R., &Navathe, S. B. Fundamentals of database systems, 4th Edition, Addison Wesley Publishing Edition, 2017.
Reference Books	
1.	Majumdar, A. K., and Bhattacharyya, P. Database Management Systems. McGraw-Hill, 2017.
2.	Raghu Ramakrishnan, Database Management Systems, Mcgraw-Hill,4th edition, 2015

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**16-09-2020**		
Approved by Academic Council	**No. 59**	**Date**	**24-09-2020**

Course Code	Course Title	L	T	P	J	C
CBS1008	Operations Research	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

The course is aimed at

1. The course emphasizes the application of Operations Research for solving Engineering problems.
2. Understand the meaning, purpose, and tools of Operations Research.
3. Critically analyze a problem, identify, formulate and solve problems in any engineering field using operations research principles, considering current and future trends.
4. The students are expected to know and understand common and important engineering problems.
5. Students will develop problem modeling and solving skills and learn how to make intelligent decisions from the point of view of opti mization.
6. The students will use optimization techniques to enhance systems and to manage enterprise resources using current tools, frameworks and reusable resources.

Expected Course Outcome:

At the end of the course, the student will be able to

1. Apply operations research techniques like L.P.P, scheduling and sequencing in industrial optimization problems.
2. Solve allocation problems using various OR methods.
3. Analyze various OR models like Inventory, Replacement, Queuing, Decision etc., and apply them for optimization.
4. Understand the concepts of integer linear programming.
5. Gain knowledge on current topics and advanced techniques of Operations Research in a wide range of applications in industries.

Module:1	Linear Programming Problems	7 hours

An overview and scope of Operations Research and Introduction to Linear Programming (LP) - Illustration of LP Problems - Formulation exercises on LP Problems - Graphical Method of solving LPP - Simplex Method – Unboundedness - Multiple Optimum Solutions - Degeneracy and Cycling Problems - Artificial Variables : Big-M Method - Sensitivity Analysis.

Module:2	Special Types of Linear Programming Problems	5 hours

Formulation of Transportation Problems - Sensitivity Analysis in Transportation Problems - Assignment Problems.

Module:3	Integer Programming Problems	4 hours

Formulation, Cutting Plane Method - Branch and Bound Method – Applications.

Module:4	Goal Programming Problems	3 hours

Single and Multiple Goal Programming Problems.

Module:5	Markov Chains	4 hours

Concepts, Transition Probabilities - Steady-State Probabilities – Applications.

Module:6	**Game Theory**	**5 hours**
Introduction - Characteristics of Game Theory - Two Person, Zero sum games - Pure strategy - Dominance theory - Mixed strategies - Algebraic and graphical methods.		
Module:7	**Contemporary issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours	**30 hours**

Text Book(s)	
1.	Kanti Swarup, Gupta P.K., and Manmohan, (2008), Operations Research, S. Chand & sons.
Reference Books	
1.	Hamdy Taha, (1999), Operations Research, PHI.
2.	S.D.Sharma, (2006), Operations Research , Kedamanth Ramnath & Co.
3.	Hira and Gupta, (2001), Operations Research, S.Chand & Sons.
4.	Panneerselvan. R. (2006), Operation Research, Prentice Hall of India Pvt Ltd.

Mode of Evaluation : Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test.

List of Challenging Experiments (Indicative)		
1.	Introduction to the software (R/LINGO/CPLEX/any suitable software packages) and general Syntaxes	2 hours
2.	Plotting and visualizing curves and surfaces – Symbolic computations	2 hours
3.	Evaluating LPP using Simplex Method	2 hours
4.	Evaluating LPP using Big M Method and Sensitivity Analysis	2 hours
5.	Evaluating Transportation Problems and Sensitivity Analysis in Transportation Problems	2 hours
6.	Evaluating Assignment Problems	2 hours
7.	Evaluating Integer Programming Problems	2 hours
8.	Evaluating problems about transition probabilities and steady-state probabilities	2 hours
9.	Evaluating problems about Game theory	2 hours
10.	Applying optimization techniques to real world problems	2 hours
	Total Laboratory Hours	**20 hours**

Mode of Evaluation: Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	**24-06-2019**		
Approved by Academic Council	**No. 59**	**Date**	**24-09-2019**

Course Code	Course Title	L	T	P	J	C
CBS1009	Computational Statistics	2	0	2	0	3
Pre-requisite	NIL	Syllabus Version				
		v. 1.0				

Course Objectives:

1. This course Introduce and understand modern computational methods used in statistics. Included are methods for simulation, estimation and visualization of statistical data. Understand the role of computation as a tool of discovery in data analysis.
2. This enables the students to understand and use the applications of statistics in the real-time problems.
3. The aim of this course is to give graduate students a solid foundation of computational statistics, which they will use in other courses and their research. This course introduces some computational methods in statistics with emphasis on the usage of statistical software packages, statistical simulation, numerical methods, and related topics.

Expected Course Outcome:

1. At the end of the course the student should be able to:
2. Analyse and interpret statistical data using multivariate normal distributions.
3. Learn the approaches to point estimation of parameters.
4. Understand the concept of multivariate regression, by using multivariate analysis and interpreting experimental data.
5. Understand the concept of statistical analysis.
6. Learn about the data aggregation, group operations and time series.

Module:1	Multivariate Normal Distribution	5 hours

Multivariate Normal Distribution Functions - Conditional Distribution and its relation to regression model - Estimation of parameters.

Module:2	Multiple Linear Regression Model	5 hours

Standard multiple regression models with emphasis on detection of collinearity – outliers - non-normality and autocorrelation - Validation of model assumptions.

Module:3	Multivariate Regression	4 hours

Assumptions of Multivariate Regression Models - Parameter estimation - Multivariate Analysis of variance and covariance.

Module:4	Discriminant Analysis and Principal Component Analysis	4 hours

Statistical background - linear discriminant function analysis - Estimating linear discriminant functions and their properties.

Principal components - Algorithm for conducting principal component analysis - deciding on how many principal components to retain - H-plot.

Module:5	Factor Analysis and Clustering and Segmentation Analysis	5 hours

Factor analysis model - Extracting common factors - determining number of factors - Transformation of factor analysis solutions - Factor scores.

Introduction - Types of clustering - Correlations and distances - clustering by partitioning methods - hierarchical clustering - overlapping clustering - K-Means Clustering-Profiling and Interpreting Clusters.		
Module:6	**Data Aggregation, Group Operations and Time series**	**5 hours**
GoupBy Mechanics - Data Aggregation - Group wise Operations and Transformations - Pivot Tables and Cross Tabulations - Time Series Basics - Data Ranges - Frequencies and Shifting.		
Module:7	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Applied Multivariate Statistical Analysis, (2007), Richard A. Johnson, Dean W. Wichern, Pearson Prentice Hall.
2.	An Introduction to Multivariate Statistical Analysis, (2003), T.W. Anderson, John Wiley, N.Y.
3.	Mark Lutz, "Programming Python", O'Reilly Media, 4th edition, 2010.
4.	Magnus Lie Hetland, "Beginning Python: From Novice to Professional", Apress, Second Edition, 2005.
Reference Books	
1.	Regression Diagnostics , Identifying Influential Data and Sources of Collinearety, (1980), D.A. Belsey, E. Kuh and R.E. Welsch
2.	Applied Linear Regression Models, (1989), J. Neter, W. Wasserman and M.H. Kutner, Homewood, Illinois.
3.	The Foundations of Factor Analysis, (1972) , A.S. Mulaik, McGraw Hill, N.Y.
4.	Introduction to Linear Regression Analysis, (2012), D.C. Montgomery and E.A. Peck, John Wiley, N.Y.
5.	Cluster analysis for Applications, (1973), M.R. Anderberg, Academic Press, N.Y.
6.	Multivariate Statistical Analysis, (1990) , D.F. Morrison, McGraw Hill, N.Y.
7.	Python for Data Analysis,(2013), Wes Mc Kinney, O'Reilly Media, 2012.

Mode of Evaluation : Digital Assignments, Continuous Assessments, Final Assessment Test

List of Challenging Experiments (Indicative)

1.	Introduction to Python – Keywords, identifiers, I/O statements.	2 hours
2.	Sequence and File operations, Functions, loops, Modules, errors and exceptions.	2 hours
3.	Data Manipulation- Basic Functionalities, Merging, Concatenation of data objects, Exploring a Dataset and Analyzing a dataset.	2 hours
4	Data visualization – Matplotlib package, Plotting Graphs, Controlling Graph, Adding Text, More Graph Types, Getting and setting values, Patches.	2 hours
5	Python Concepts, Data Structures - Interpreter, Program Execution, Statements, Expressions, Flow Controls, Functions.	2 hours
6.	Numeric Types, Sequences and Class Definition, Constructors, Text & Binary Files – Reading and Writing	2 hours
7	Data Wrangling: Combining and Merging Datasets, Reshaping and Pivoting, Data	2 hours

	Transformation, String Manipulation, Regular Expressions	
8	Multivariate Analysis: Graphical representation of multivariate data; Principal Component Analysis.	2 hours
9	Factor Analysis and Cluster Analysis.	2 hours
10	Model Sampling from multivariate normal distribution; MANOVA; Discriminant Analysis.	2 hours
	Total Laboratory Hours	**20 hours**

Mode of Evaluation : Weekly Assessments, Final Assessment Test			
Recommended by Board of Studies	**24-06-2019**		
Approved by Academic Council	**No. 59**	**Date**	**24-09-2019**

Course Code	Course Title	L	T	P	J	C
CBS2002	Formal Language and Automata Theory	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To gain knowledge on formal methods and languages
2. Distinguish different computing models and classify their respective types
3. Show a competent understanding of the basic concepts of complexity theory

Expected Course Outcome:

1. Demonstrate the knowledge of mathematical models of computation and describe how theyrelate to formal languages
2. Derive an appropriate model of computation for a given language and vice versa.
3. Infer the equivalence of languages described using different automata or grammars.
4. Distinguish the computability power of automata and their limitations

Module:1	Introduction	5 hours

Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.

Module:2	Regular languages and finite automata	8 hours

Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, Kleene's theorem, pumping lemma for regular languages, Myhill-Nerode theorem and its uses, minimization of finite automata.

Module:3	Context-free languages and pushdown automata	7 hours

Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs.

Module:4	Context-sensitive languages	4 hours

Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.

Module:5	Turing machines	7 hours

The basic model for Turing machines (TM), Turing recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators.

Module:6	Undecidability	6 hours

Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages.

Module:7	**Basic Introduction to Complexity**	**6 hours**
Introductory ideas on Time complexity of deterministic and nondeterministic Turing machines, P and NP,NP- completeness, Cook's Theorem, other NP -Complete problems.		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Hopcroft, John E., Rajeev Motwani, and Jeffrey D. Ullman. Introduction to Automata Theory, Languages, and Computation, Pearson Education, 3rd Edition, 2013.
2.	Martin, J. C. Introduction to Languages and the Theory of Computation. New York: McGraw-Hill, 4th Edition, 2007.
Reference Book(s)	
1.	Lewis, H. R., and Papadimitriou, C. H. Elements of the Theory of Computation. Prentice Hall of India Private Limited, 2015.
2.	Dexter C. Kozen. Automata and computability. Springer Science & Business Media, 2012.
3.	Sipser, M. Introduction to the Theory of Computation. Cengage learning, 2012.

Mode of Evaluation: CAT / FAT / Project			
Recommended by Board of Studies	**16- 09-2020**		
Approved by Academic Council	**No. 59**	**Date**	**24-09-2020**

Course Code	Course Title	L	T	P	J	C
CBS2003	Design Thinking	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. Recognize the importance of design thinking and its various phases
2. Apply design thinking phases to create successful prototypes
3. Understand that both agile and design thinking process complement each other

Expected Course Outcome:

After the successful completion of the course the student should be able to

1. Understand the importance of design thinking and its different phases
2. Empathize with user situations and be able to define clear problem statements
3. Use the different ideation methods and come with different feasible and viable ideas for solving the problem statements.
4. Create prototypes for clear understanding of the problem statement.
5. Test the created prototypes and be able to iterate if the design does not meet the customer requirement
6. Complement agile process with design thinking for efficient delivery process.

Module:1	Introduction to Design Thinking	3 hours

Importance of Design Thinking – Phases in design thinking process – Five stage model – Non-linearity of the five-stage model – Applications of design thinking in various domains.

Module:2	Empathize Phase	4 hours

Empathy – Empathize with the users - Steps in empathize phase – Developing empathy towards people – Assuming a beginner's mindset – Ask What? And Why? – Immersion Activity – Steps in immersion activity - Body Storming – Case studies.

Module:3	Define Phase	5 hours

Define the problem and interpret the result – Analysis and synthesis – Personas – Four different perspectives on Personas – Steps to creating personas – Problem statement – Affinity diagrams – Empathy mapping – Point of View – "How might we" questions – Why-how laddering – Case studies.

Module:4	Ideate	6 hours

What is ideation – Need for ideation – Uses of ideation – Ideation Methods – Brainstorming – Rules for brainstorming – Mind maps – Guidelines to create mind maps – Ideation games - Six Thinking Hats – Doodling – Use of doodling in expressing creative ideas – Case studies.

Module:5	Prototype	4 hours

Prototyping – Types of prototyping – Guidelines for prototyping – Story telling – Characteristics of good stories – Reaching users through stories – Importance of prototyping in design thinking – Value proposition - Guidelines to write value proposition – Case studies.

Module:6	Test	4 hours

Need to test –User feedback - Conducting a user test – Guidelines for planning a test – How to test - Desirable, feasible and viable solutions – Iterate phase.		
Module:7	**Role of Design Thinking**	**3 hours**
Software and good design - Design thinking and coding – Agile Methodology – Differences between agile and design thinking - Complementing agile with design thinking		
Module:8	**Contemporary Issues**	**1 hour**
	Total Lecture hours:	**30 hours**
Lab Experiments		
1	Immersion Activity	3 hours
2	Problem Definition	3 hours
3	Different Points of View	3 hours
4	Brainstorming session	3 hours
5	Drawing Mind Maps	3 hours
6	Ideation Games	3 hours
7	Creating Prototype	3 hours
8	Planning and working on video storyboard	3 hours
9	Completing the prototype as per schedule	3 hours
10	Testing the prototype	3 hours
	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires, 1st Edition, HarperCollins, 2009.	
2.	Eli Woolery, Design Thinking Handbook, Invision, 2019.	
Reference Books		
1.	Nir Eyal , Hooked: How to build habit-forming, 2014	
2.	Rod Judkins, The Art of Creative Thinking, Sceptre; 1st edition, 2015.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab		
Recommended by Board of Studies	**29-01-2021**	
Approved by Academic Council	**No. 61**	**Date** **18-02-2021**

Course code	Course Title	L	T	P	J	C
CBS3001	Computer Networks	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 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 ISO- OSI layered Architecture
3. Deal with the major issues of the layers of the model.

Expected Course Outcome:

1. Interpret the different building blocks of Communication network and its architecture.
2. Contrast different types of switching networks and analyse the performance of network
3. Implement various error detection and correction mechanisms, flow control mechanisms and various routing protocols
4. Design subletting and analyse the performance of network layer, Construct and examine various routing protocols
5. Understand the functionality of various layer and its associated protocols

Module:1	Introduction to Computer Networks	4 hours

Introduction: Computer networks and distributed systems, Classifications of computer networks, Preliminaries of layered network structures. **Data communication Components:** Representation of data and its flow, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media.

Module:2	Network Topology and Bandwidth	3 hours

LAN: Wired LAN, Wireless LAN, Virtual LAN. **Techniques for Bandwidth utilization:** Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

Module:3	Data Link Layer and Medium Access SubLayer	5 hours

Fundamentals of Error Detection and Error Correction, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go-back–N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols - Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA

Module:4	Network Layer	5 hours

Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

Module:5	**Transport Layer**	**6 hours**
Process to Process Communication, User Datagram Protocol (UDP), Transmission ControlProtocol (TCP), SCTP Congestion Control; Quality of Service (QoS), QoS improving techniques - Leaky Bucket and Token Bucket algorithms.		
Module:6	**Application Layer**	**3 hours**
DNS, DDNS, TELNET, EMAIL, FTP, WWW, HTTP, SNMP, Bluetooth, Firewalls.		
Module:7	**Network Security**	**2 hours**
Electronic mail, directory services and network management, Basic concepts of Cryptography.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Tanenbaum, Computer Networks, Pearson Education, 5th Edition, 2013.
2.	William Stallings. Data and computer communications. Pearson Education India, 2013.
Reference Book(s)	
1.	Perlman, R., Kaufman, C., and Speciner, M. (2016). Network security: private communication in a public world. Pearson Education India.
2.	Stevens, W. R., Fenner, B., and Rudoff, A. M. (2018). UNIX Network Programming Volume 1. SMIT-SMU.

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

List of Challenging Experiments (Indicative)		
1.	Demo session of all networking hardware and Functionalities	2 hours
2.	Network System Administration: Understanding switches and routers	2 hours
3.	Network configuration commands using Linux	2 hours
4.	Error detection and correction mechanisms	2 hours
5.	Flow control mechanisms	2 hours
6.	Simulation of unicast routing protocols	2 hours
7.	Observing Packets across the network and Performance Analysis of Routing protocols	2 hours
8.	Socket programming (TCP and UDP) – Multi client chatting	2 hours
9.	Develop a DNS client server to resolve the given host name or IP address	2 hours
10.	Implementation of Layers for security protocols - SSL/TLS	2 hours
	Total Laboratory Hours	30 hours

Mode of assessment:

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

Course code	Course Title	L	T	P	J	C
CBS3002	Information Security	2	0	2	0	3
Pre- requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To study and practice fundamental techniques in developing secure applications
2. To understand the policy, procedures and guidelines to protect the computing resources

Expected Course Outcome:

1. To understand security parameters and access control methods.
2. To understand the fundamental policies and design principle of computing resources
3. To recognize system design, logic-based system
4. To study the security architecture of database, operating system and associated vulnerabilities

Module:1		4 hours

Overview of Security Parameters: Confidentiality, integrity and availability; Security violation and threats; Security policy and procedure; Assumptions and Trust; Security Assurance, Implementation and Operational Issues; Security Life Cycle.

Module:2		3 hours

Access Control Models: Discretionary, mandatory, roll-based and task-based models, unified models, access control algebra, temporal and spatio-temporal models.

Module:3		5 hours

Security Policies: Confidentiality policies, integrity policies, hybrid policies, non-interferenceand policy composition, international standards.

Module:4		5 hours

Systems Design: Design principles, representing identity, control of access and information flow, confinement problem. Assurance: Building systems with assurance, formal methods, evaluating systems.

Module:5		6 hours

Logic-based System: Malicious logic, vulnerability analysis, auditing, intrusion detection. Applications: Network security, operating system security, user security, program security.Special Topics: Data privacy, introduction to digital forensics, enterprise security specification.

Module:6		3 hours

Operating Systems Security: Security Architecture, Analysis of Security in Linux/Windows.

Module:7		2 hours

Database Security: Security Architecture, Enterprise security, Database auditing.

Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Anderson, R. Security engineering. John Wiley & Sons, 2008.
2.	Bishop, M. Computer Security: Art and Science. Pearson Education, Boston, US, 2003.
3.	Stamp, M. Information security: principles and practice. John Wiley & Sons, 2014.
Reference Book(s)	
1.	Pfleeger, C. P., Pfleeger, S. L., and Margulies, J. Security in Computing,ProQuest Safari Tech Books Online, 2017.
2.	Wheeler, D. A. Secure programming HOWTO, 2017.
3.	Zalewski, M. Google browser security handbook, 2009.
4.	Gertz, M., & Jajodia, S. (Eds.). Handbook of database security: applications andtrends. Springer Science & Business Media, 2007.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	Analysis of security in Unix/Linux.	2 hours
2.	Administration of users, password policies, privileges and roles	2 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	**09-09-2020**		
Approved by AcademicCouncil	**No.59**	**Date**	**24-09-2020**

Course Code	Course Title	L	T	P	J	C
CBS3003	Design and Analysis of Algorithms	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. Analyze the asymptotic performance of algorithms.
2. Apply important algorithmic design paradigms and methods of analysis.
3. Synthesize efficient algorithms in common engineering design situations.

Expected Course Outcome:

1. Analyse worst-case running times of algorithms using asymptotic analysis.
2. Identify suitable algorithmic paradigm for solving the given problem
3. Understand and apply various graph-based algorithms
4. Understand the classes of complexity
5. Introduction to approximation, randomized and quantum algorithms
6. Describe various algorithmic strategies, analysis and their implementation

Module:1	Introduction to algorithmic analysis	8 hours

Characteristics of Algorithm. Analysis of Algorithm: Asymptotic analysis of Complexity Bounds – Best, Average and Worst-Case behavior; Performance Measurements of Algorithm, Time and Space Trade-Offs, Analysis of Recursive Algorithms through Recurrence Relations: Substitution Method, Recursion Tree Method and Masters' Theorem.

Module:2	Fundamental Algorithmic Strategies	7 hours

Brute-Force, Heuristics, Branch and Bound and Backtracking methodologies; Illustrations of these techniques for Problem-Solving, Bin Packing, Knapsack, Travelling Salesman Problem.

Module:3	Greedy and Dynamic Programming	8 hours

Dynamic Programming--Elements of Dy Programming, Rod Cutting, Matrix chain multiplication, Longest Common Subsequence; Greedy Algorithms- Activity Selection Problem, Elements of greedy strategy, Knapsack proble, Huffman Coding; Fibonacci Heaps

Module:4	Graph and Tree Algorithms	5 hours

Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.

Module:5	Tractable and Intractable Problems	8 hours

Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems and Reduction techniques

Module:6	Approximation and Randomized algorithms	5 hours

Performance ratios for approximation algorithms, approximation scheme, APPROX-VERTEX-COVER, APPROX-TSP Tour, GREEDY-SET-COVER, Randomized algorithms

Module:7	**Quantum Algorithms**	**2 hours**
Introduction to Quantum Algorithms		
Module:8	**Contemporary issues**	**2 hours**
Recent trends in algorithmic strategies and analysis		
	Total Lecture hours:	**45 hours**

Lab Experiments		
1	Implementation of various data structures (recap)	2 hours
2	Computing the time complexity of the given algorithms	2 hours
3	Brute force strategy	2 hours
4	Greedy strategy -Activity selection, knapscak	4 hours
5	Dynamic programming- MCM, LCS and 0/1 knapsack	6 hours
6	Branch and Bound strategy	2 hours
7	Backtracking -8 Queens problem	2 hours
8	Graph search algorithms	2 hours
9	Minimum Spanning Tree	2 hours
10	Shortest path algorithm	2 hours
11	Network flow –Min cut	2 hours
12	Approximation algorithms- TSP and vertex cover	2 hours
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Horowitz, E., Sahni, S., & Rajasekaran, S. Fundamental of computer algorithms, Hyderabad, Universities Press; Second edition, 2008.
2.	Kleinberg J, Tardos E. Algorithm design. Pearson Education India; 2006
Reference Books	
1.	Knuth Donald E, "Art of Computer Programming: Fundamental Algorithms Volume 1 - Fundamental Algorithms", Third Edition, Pearson Publishers, 2011.
2.	Pat Morin, "Open Data Structures: An Introduction (Open Paths to Enriched Learning)", 31st ed. Edition, UBC Press, 2013.1974.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS3004	Artificial Intelligence	2	0	2	0	3
Pre-requisite	NIL		Syllabus version			
			v. 1.0			

Course Objectives:

1. To impart artificial intelligence principles, techniques and its history.
2. To assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving engineering problems.
3. To develop intelligent systems by assembling solutions to concrete computational problems

Expected Course Outcome:

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. Demonstrate knowledge of reasoning and knowledge representation for solving real worldproblems.
4. Analyze and illustrate how search algorithms and planning play vital role in problem solving.
5. Discuss current scope and limitations of AI and societal implications.
6. Illustrate and implement the construction of basic AI models and expert systems.

Module:1	Introduction, Overview of Artificial intelligence	4 Hours

Problems of AI, AI technique, Tic - Tac - Toe problem. Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal-based agents, utility-based agents, learning agents.

Module:2	Problem Solving, Problems, Problem Space & search	3 Hours

Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs.

Module:3	Search techniques	5 Hours

Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. Heuristic search strategies Greedy best-first search, A* search, AO* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search.

Module:4	Constraint satisfaction problems	4 Hours

Local search for constraint satisfaction problems. Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.

Module:5	Knowledge & reasoning	5 hours

Knowledge representation issues, representation & mapping, approaches to knowledge representation. Using predicate logic, representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction. Representing knowledge using rules, Procedural verses declarative knowledge, logic programming, forward verses backward reasoning, matching, control knowledge.

Module:6	**Probabilistic Reasoning**	**4 Hours**
Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster- Shafer theory, Planning Overview, components of a planning system, Goal stack planning,Hierarchical planning, other planning techniques.		
Module:7	**Expert Systems**	**3 Hours**
Representing and using domain knowledge, expert system shells, and knowledge acquisition.		
Module:8	**Contemporary issues**	**2 Hours**
Recent trends in Artificial Intelligence		
	Total Lecture Hours	**30 Hours**

Lab Experiments

1.	Solving Missionaries and cannibals problems	3 Hours
2.	Water Jug Problem	3 Hours
3.	8-Queens Problem	3 Hours
4.	Travelling Salesman Problem	3 Hours
5.	Solving Wampus Problem using Logic	3 Hours
6.	Monkeys and Bananas Problem using Logic	3 Hours
7.	Bayesian Classification Problem	3 Hours
8.	Decision Tree Problem	3 Hours
9.	Developing a sentiment analysis systems	3 Hours
10.	Development of Medical Expert system with Recommendation system	3 Hours
	Total Lecture hours:	**30 Hours**

Text Book(s)

1.	Russell, S. and Norvig, P. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall., 2015.
2.	Poole, D. and Mackworth, A. Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010

Reference Books

1.	Ric, E., Knight, K and Shankar, B. Artificial Intelligence, 3rd edition, Tata McGraw Hill. 2009
2.	Luger, G.F.. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson, 2008.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS3011	Usability Design of Software Applications	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To create a learning system through which management students can enhance their innovation and creative thinking skills
2. To acquaint themselves with the special challenges of starting new ventures
3. To use IPR as an effective tool to protect their innovations and intangible assets from exploitation

Expected Course Outcome:

1. To sensitize the students to the fundamentals of User Centred Design and User Experience their relevance and contribution to businesses
2. Familiarize them to the facets of User Experience (UX) Design, particularly as applied to the digital artefacts
3. Appreciation of user research, solution conceptualization and validation as interwoven activities in the design and development lifecycle
4. Acquire the ability to constructively engage with the Design professionals they would work with in the future
5. Analyse and identify the methods to offer a better UI experience for the applications
6. Gain expertise in redesigning an existing Application or website for better user experience

Module:1	Introduction to User Centred Design	3 hours

Basics of User Centered Design

Module:2	Aspects of User Centred Design	4 hours

Product Appreciation Assignment – Evaluating the product from user centered design aspects such as functionality, ease of use, ergonomics, and aesthetics.

Module:3	Heuristic Evaluation	6 hours

10 Heuristic Principles, Examples Heuristic Evaluation: Group Assignment initiation (Website and App) Evaluation for key tasks of the app or website for heuristic principles, severity, recommendations.

Module:4	Project design lifecycle	4 hours

Redesign project through the design lifecycle – Discovery - Define – Design - Implement (Design Prototype) - Usability Testing

Module:5	UX Research	5 hours

Understanding users, their goals, context of use, and environment of use. Research Techniques: Contextual Enquiry, User Interviews, Competitive Analysis for UX

Module:6	Personas and Scenarios	3 hours

Scenarios and Persona Technique –Overview of Design Thinking Technique - Discovery and brainstorming

Module:7	**Development and Prototyping**	**3 hours**
Concept Development - Task flow detailing for the Project - PrototypingTechniques - Paper, Electronic, and Prototyping Tools.		
Module:8	**Contemporary issues**	**2 hours**
Guest lecture by Industry Experts		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Jennifer Preece, Helen Sharp, Yvonne Rogers, "Interaction Design: Beyond Human-Computer Interaction", 2015, 4th Edition, Wiley publications.
Reference Books	
1.	Alan Cooper and Robert Riemann, "About Face The Essentials of Interaction Design", 2014, 4th Edition, Wiley Publications.
2.	Elizabeth Goodman, Mike Kuniavsky, Andrea Moed , " Observing the User Experience - A Practitioner's Guide to User Research" , 2012, Second Edition, Morgan Kaufmann Publications.

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

List of Indicative Experiments		
1.	Identify a website or an App to redesign, with justification	3 hours
2.	Analysis of the mobile app or the website through the design life cycle	6 hours
3.	Identifying Personas and Scenarios for the App or the website	6 hours
4.	Concept development and task flow detailing	6 hours
5.	Prototype development with Iterations and justification	6 hours
6.	Usability testing and demonstration	3 hours
	Total Hours:	**30 hours**

Mode of Assessment: Assessments/Midterm lab/Project/FAT

Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course Code	Course Title	L	T	P	J	C
CBS3012	IT Project Management	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To effectively plan, manage, execute, and control projects within the stipulated time
2. To effectively manage cost targets with a focus on Information Technology and Service Sector
3. To understand various agile project management techniques such as Scrum and DevOps.

Expected Course Outcome:

1. To understand Project Management activities and to identify basic project management skills with a strong emphasis on issues and problems associated with delivering successful IT projects.
2. To Develop activity network to use PERT and to manage project risks such as Resource scheduling and cost control.
3. To understand the concept of Agile Project Management and IT Service Management.
4. To understand the various terminologies and best practices followed in scrum.
5. To learn the concept of Devops and its Working, Automated testing and test driven methods and continuous deployment.
6. To demonstrate the working of IT Project Management with various tools and technologies.

Module:1	Project Overview and Feasibility Studies	3 hours

Project Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal.

Module:2	Project Scheduling	5 hours

Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.

Module:3	Cost Control and Scheduling	3 hours

Project Cost Control (PERT/Cost), Resource Scheduling & Resource Levelling

Module:4	Project Management Features	3 hours

Risk Analysis, Project Control, Project Audit and Project Termination

Module:5	Agile Project Management	5 hours

Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL).

Module:6	Scrum	4 hours

Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum.

Module:7	DevOps	5 hours

Overview and its Components, Containerization Using Docker, Managing Source Code and Automating

Builds, Automated Testing and Test-Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring, Other Agile Methodologies: Introduction to XP, FDD, DSDM, Crystal.		
Module:8	**Contemporary issues**	**2 hours**
Industry expert Lecture		
	Total Lecture hours	**30 hours**

Text Book	
1.	Mike Cohn, Succeeding with Agile: Software Development Using Scrum, 2015, 1st Edition Addison-Wesley Professional.
Reference Books	
1.	Roman Pichler, Agile Product Management with Scrum: Creating Products that Customers Love, 2011, First edition , Addison-Wesley.
2.	Ken Schwaber, Agile Project Management with Scrum, 2014,1st edition, Microsoft Press US.

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

Lab Experiments		
1	Estimate the IT Project Cost and Control using open-source tools	3 hours
2	Scheduling a Project with PERT and CPM: 1. Estimation of the total time required to complete the project if no delay 2. The individual activities to meet the project completion time. 3. Identify the critical bottleneck activities where any delays must be avoided to prevent delaying project completion.	6 hours
4	IT project risk analysis using open-source tools	6 hours
5	Design IT Project Audit Template	3 hours
6	Agile Project Management Tools (Open source)	3 hours
7	Design IT Service Management (ITIL) Templates	3 hours
8	Scrum: IT Project Management, DevOps and Automated Testing Tools	6 hours
	Total Hours	**30 hours**

Mode of Assessments: Assessment /Midterm Lab/ FAT

Recommended by Board of Studies	**22-05- 2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course Code	Course Title	L	T	P	J	C
EEE1001	Basic Electrical and Electronics Engineering	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To understand the various laws and theorems applied to solve electric circuits and networks
2. To provide the students with an overview of the most important concepts in Electrical and Electronics Engineering which is the basic need for every engineer

Expected Course Outcome:

1. Solve basic electrical circuit problems using various laws and theorems
2. Analyze AC power circuits and networks, its measurement and safety concerns
3. Classify and compare various types of electrical machines
4. Design and implement various digital circuits
5. Analyze the characteristics of semiconductor devices and comprehend the various modulation techniques in communication engineering
6. Design and conduct experiments to analyze and interpret data

Module:1	DC circuits	5 hours

Basic circuit elements and sources, Ohms law, Kirchhoff's laws, series and parallel connection of circuit elements, Node voltage analysis, Mesh current analysis, Thevenin's and Maximum powertransfer theorem.

Module:2	AC circuits	6 hours

Alternating voltages and currents, AC values, Single Phase RL, RC, RLC Series circuits, Power in AC circuits-Power Factor- Three Phase Systems – Star and Delta Connection- Three Phase Power Measurement – Electrical Safety –Fuses and Earthing, Residential wiring.

Module:3	Electrical Machines	7 hours

Construction, Working Principle and applications of DC Machines, Transformers, Single phase and Three-phase Induction motors, Special Machines-Stepper motor, Servo Motor and BLDC motor.

Module:4	Digital Systems	5 hours

Basic logic circuit concepts, Representation of Numerical Data in Binary Form- Combinational logic circuits, Synthesis of logic circuits

Module:5	Semiconductor devices and Circuits	7 hours

Conduction in Semiconductor materials, PN junction diodes, Zener diodes, BJTs, MOSFETs, Rectifiers, Feedback Amplifiers using transistors. Communication Engineering: Modulation and Demodulation - Amplitude and Frequency Modulation

Total Lecture hours:	30 hours

Text Book(s)

1. John Bird, 'Electrical circuit theory and technology ', Newnes publications, 4th Edition, 2010.

Reference Books:		
1.	Allan R. Hambley, 'Electrical Engineering -Principles & Applications' Pearson Education, First Impression, 6/e, 2013	
2.	Simon Haykin, 'Communication Systems', John Wiley & Sons, 5 t h Edition, 2009.	
3.	Charles K Alexander, Mathew N O Sadiku, 'Fundamentals of Electric Circuits', Tata McGraw Hill, 2012.	
4.	Batarseh, 'Power Electronics Circuits', Wiley, 2003	
5.	H. Hayt, J.E. Kemmerly and S. M. Durbin, 'Engineering Circuit Analysis', 6/e, Tata McGraw Hill, New Delhi, 2011.	
7.	Fitzgerald, Higgabogan, Grabel, 'Basic Electrical Engineering', 5t h edn, McGraw Hill, 2009.	
8.	S.L.Uppal, 'Electrical Wiring Estimating and Costing ', Khanna publishers, NewDelhi, 2008.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	Thevenin's and Maximum Power Transfer Theorems – Impedance matching of source and load	3 hours
2.	Sinusoidal steady state Response of RLC circuits	3 hours
3.	Three phase power measurement for ac loads	3 hours
4.	Staircase wiring circuit layout for multi storey building	3 hours
5.	Fabricate and test a PCB layout for a rectifier circuit	3 hours
6.	Half and full adder circuits.	3 hours
7.	Full wave Rectifier circuits used in DC power supplies. Study the characteristics of the semiconductor device used	3 hours
8.	Regulated power supply using zener diode. Study the characteristics of the Zener diode used	3 hours
9.	Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars. Study the characteristics of the transistor used	3 hours
10.	Characteristics of MOSFET	3 hours
	Total Laboratory Hours	**30 hours**
Mode of assessment: CAT / Assignment / Quiz / FAT / Project / Seminar		
Recommended by Board of Studies	**29-05-2015**	
Approved by Academic Council	**No. 37**	**Date** **17-06-2015**

Course Code	Course Title	L	T	P	J	C
MAT1004	Discrete Mathematics	3	0	0	0	3
Pre-requisite	NIL	Syllabus Version				
		v. 1.0				

Course Objectives:

The aim of this course -

1 To cover certain sets, functions, relations and groups concepts for analyzing problems that arise in engineering and physical sciences.

2 To imparting to analyze the problems connected with combinatorics and Boolean algebra.

3 To solve calculus and integral calculus problems.

Expected Course Outcome

At the end of the course the student should be able to

1. Observe the various types of sets, functions and relations.
2. Understand the concepts of group theory.
3. Understand the concepts of combinatorics.
4. Understand the concepts of graph theory and its applications.
5. Learning logic and Boolean algebra. Using these concepts to solve the problems.

Module:1	Set, Function and Relation	5 hours

Introduction to set – Subset – Types of set – Operation of sets – Principle of inclusion and exclusion – Laws of set theory – Functions – One-one and onto functions – Relations – Types of relation – Equivalence relations.

Module:2	Algebraic Structures	8 hours

Semigroup – Monoids – Groups – Subgroups – Abelian groups – Lagrange's theorem – Rings (examples only) – Integral domain – Fields – Definition and examples.

Module:3	Combinatorics	8 hours

Introduction to Basic Counting Principles, Formulae behind nP_r, nC_r - Balls and Pins problems - Pigeon-Hole Principle - Recurrence relations – Generating Functions - Introduction to Proof Techniques - Mathematical Induction

Module:4	Basic Graph Theory	4 hours

Graphs and digraphs, complement, isomorphism, connectedness and reachability, adjacency matrix, Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs and tournaments

Module:5	Trees, Planer graph and colouring of a graph	6 hours

Trees; Planar graphs, Euler's formula, dual of a planer graph, independence number and clique number, chromatic number, statement of Four-color theorem

Module:6	Logic	7 hours

Propositional calculus - propositions and connectives, syntax; Semantics - truth assignments and truth

tables, validity and satisfiability, tautology; Adequate set of connectives; Equivalence and normal forms; Compactness and resolution; Formal reducibility - natural deduction system and axiom system; Soundness and completeness		
Module:7	**Boolean Algebra**	**5 hours**
Introduction of Boolean algebra, truth table, basic logic gate, basic postulates of Boolean algebra, principle of duality, canonical form, Karnaugh map.		
Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	I. N. Herstein, "Topics in Algebra", John Wiley and Sons.
2.	M. Morris Mano, "Digital Logic & Computer Design", Pearson.
3.	C. L. Liu, "Elements of Discrete Mathematics:, second edition, LiuMcGraw Hill, New Delhi.
4.	J. A. Bondy and U. S. R. Murty, "Graph Theory with Applications ", Macmillan Press, London.
5.	L. Zhongwan, "Mathematical Logic for Computer Science ", World Scientific, Singapore
Reference Books	
1.	Gilberft Strang, "Introduction to Linear Algebra".
2.	R. A. Brualdi, "Introductory Combinatorics", , North-Holland, New York.
3.	N. Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall, Englewood Cliffs.
4.	E. Mendelsohn, "Introduction to Mathematical Logic, (Second Edition)", Van-Nostrand, London.

Mode of Evaluation: CAT/Quiz/Digital assignment, Seminar and FAT			
Recommended by Board of Studies	**10-09-2019**		
Approved by Academic Council	**No. 56**	**Date**	**24-09-2019**

Course Code	Course Title	L	T	P	J	C
MAT2004	Linear Algebra	3	2	0	0	4
Pre –requisite	Discrete Mathematics	Syllabus Version				
		v. 1.0				

Course Objectives:

The aim of this course:

1. Is to cover certain solution of system of linear equations, vector space and orthogonality concepts for analyzing problems that arise in engineering and physical sciences.
2. Is imparting to analyze the problems connected Eigen value, Hermitian and Unitary linear transformations.
3. Is to solve QR and LU decomposition and to learn the applications of linear algebra in computer science.

Expected Course Outcome:

At the end of the course the student should be able to

1. Observe the various types of matrix, determinant and its properties.
2. Understand the concepts of system of linear equations and solving by various methods.
3. Understand the concepts of vector space, subspace and basis.
4. Understand the concepts of orthogonality, Hermitian and unitary transformations.
5. Learning the applications in Image processing, Machine learning and Cryptography.

Module:1	Matrices and Determinants	4 hours

Introduction to Matrices – Types of Matrices – Determinants – Properties – Rank of a Matrix.

Module:2	System of Linear Equations	4 hours

Solutions of linear equations – Cramer's rule – Matrix inversion method – Consistency and inconsistency method.

Module:3	LU Decompositions	7 hours

Gaussian elimination – Gauss Jordan method to find the inverse of a matrix – Elementary matrices – Block Matrices – LU Decomposition.

Module:4	Vector Spaces	9 hours

Vector space – Sub space – Linearly independent – linearly dependent – Dimension – Basis – Dimension of sub space – Interpolating polynomial vectors – Co –ordinate vectors.

Module:5	Orthogonality	6 hours

Orthogonality – Projection – Gram Schmidt orthogonalization – QR decomposition – Isometry linear transformations.

Module:6	Hermitian and Unitary Linear Transformations	7 hours

Eigen values – Eigen vectors – Positive definite matrices – linear transformations – Hermitian and unitary Transformations.

Module:7	Applications of Linear Algebra	6 hours

Singular value decomposition and principal component analysis – Introduction to their applications in image processing and machine learning – Coding and Decoding – Least Square solutions.

Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**
Tutorial: A minimum of five problems to be worked out by students in every Tutorial Class. Another five problems per tutorial class to be given as home work.		**15 hours**

Text Book(s)

1.	Jin Ho Kwak and Snngpyo Hong, Linear Algebra, Second Edition, Springer (2004).
2.	Bernard Kolman and David R. Hill, Introductory Linear Algebra – An Applied Course, 9th Edition, Pearson Education, 2011.

Reference Books

1.	Gilbert Strang, Introduction to linear algebra, 4th Edition, Academic Press.
2.	Howard Anton and Robert C Busby, Contemporary Linear Algebra, John Wiley (2003).
3.	R C Gonzalez and R E Woods, Digital Image Processing.
4.	https://machinelearningmastery.com/introduction –matrices –machine –learning/

Mode of Evaluation: CAT, Quiz, Digital assignment, Seminar and FAT			
Recommended by Board of Studies	**10-09-2019**		
Approved by Academic Council	**No. 56**	**Date**	**24-09-2019**

Course code	Course Title	L	T	P	J	C
MAT2005	Data Science and Statistical Modelling	2	0	2	0	3
Pre-requisite	MAT 1017	Syllabus version				
		v. 1.0				

Course Objectives:

1.To explain the role of statistics in business
2. To impart knowledge on collection, analysis and presentation of data
3. To analyse distributions and relationships of real-time data.
4. To apply estimation and testing methods to make inference and modeling techniques for decision making.

Expected Course Outcome: After completing the course, the student should be able to

1. Present and analyze scientific data
2. Solve problems on probability
3. Interpret statistical test outcomes
4. Design and analyze experiments
5. Appreciate the applications of statistical methods in science and engineering
6. Apply relevant statistical analysis to experimental data

Module:1	**Linear Statistical Models**	**4 hours**
Simple linear regression & correlation, multiple regression & multiple correlation		
Module:2	**Estimation**	**6 hours**
Point estimation, criteria for good estimates (un-biasedness, consistency), Methods of estimation including maximum likelihood estimation.		
Module:3	**Sufficient Statistic**	**4 hours**
Concept & examples, complete sufficiency, their application in estimation		
Module:4	**Test of hypothesis**	**8 hours**
Concept & formulation, Type I and Type II errors, Neyman Pearson lemma, Procedures of testing, Analysis of variance (one way, two way with as well as without interaction)		
Module:5	**Non-parametric Inference**	**6 hours**
Comparison with parametric inference, Use of order statistics. Sign test, Wilcoxon signed rank test, Mann-Whitney test, Run test, Kolmogorov-Smirnov test. Spearman's and Kendall's test.		
Module:6	**Expert Lecture**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Books

1. Probability and Statistics for Engineers (4th Edition), I.R. Miller, J.E. Freund and R. Johnson.
2. Fundamentals of Statistics (Vol. I & Vol. II), A. Goon, M. Gupta and B.Dasgupta
3. The Analysis of Time Series: An Introduction, Chris Chatfield

Reference Books		
1.	Introduction to Linear Regression Analysis, D.C. Montgomery & E.Peck	
2.	Introduction to the Theory of Statistics, A.M. Mood, F.A. Graybill& D.C. Boes.	
3.	Applied Regression Analysis, N. Draper & H. Smith	
4.	Hands-on Programming with R,- Garrett Grolemund	
5	R for Everyone: Advanced Analytics and Graphics, Jared P. Lander	
6	**Data Source**: www.rbi.org.in	
List of Experiments		
1.	Introduction to R software Understanding Data types; importing/exporting data.	1 hours
2.	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations.	2 hours
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination	1 hours
4.	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficient of determination	2 hours
5.	Testing of hypothesis for One sample mean and proportion from real-time problems.	1 hours
6.	Testing of hypothesis for Two sample mean and proportion from real-time problems	2 hours
7.	Performing ANOVA for real dataset for Randomized Block design	2 hours
8.	Latin square Design	1 hours
9.	Non parametric Sign test and Wilcoxon signed rank test	2 hours
10.	Mann-Whitney test	1 hours
Mode of Evaluation: Assignments, Quiz, Continuous Assessments, Seminar and FAT		
Recommended by Board of Studies	**10-09-2019**	
Approved by Academic Council	**No.56**	**Date** **24-09-2019**

Course Code	Course Title	L	T	P	J	C
MGT1064	Financial And Cost Accounting	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To create an awareness about the importance and usefulness of the accounting concepts and their managerial implications
2. To develop an understanding of the financial statements and the underlying principles and learn to interpret financial statements
3. To create an awareness about cost accounting, different types of costing and cost management

Expected Course Outcome:

After completion of the course, student should be able to

1. Enable the budding Technocrat Managers to understand the Financial Accounting Concepts
2. Process the accounting transactions leading to final statement of accounts
3. Analyze the Annual Reports
4. Prepare the FFS and CFS
5. Understand the Costing concepts and make decisions using Marginal costing concepts and budgets

Module:1	Introduction	2 hours

Accounting Concept: Introduction, Techniques and Conventions, Financial Statements- Understanding & Interpreting Financial Statements

Module:2	Accounting Process	6 hours

Book Keeping and Record Maintenance, Fundamental Principles and Double Entry, Journal, Ledger, Trial Balance, Cash Book and Subsidiary Books, Rectification of Errors.

Module:3	Financial Statements	12 hours

Form and Contents of Financial Statements- Trading and Profit and Loss Account, Balance Sheet - Final Accounts-analysing and Interpreting Financial Statements, Accounting Standards.

Module:4	Company Accounts	3 hours

Audit Reports and Statutory Requirements (in the context of Annual Reports), Directors Report, Notes to Accounts, Pitfalls.
Class Discussion: Corporate Accounting Fraud A Case Study of Satyam

Module:5	Cash and Fund Flow	8 hours

Introduction, How to prepare, Difference between them

Module:6	Costing Systems	6 hours

Elements of Cost, Cost Behavior, Cost Allocation, OH Allocation, Unit Costing, Process Costing, Job Costin, Absorption Costing, ABC Analysis.
Class Discussion: Application of costing concepts in the Service Sector

Module 7	Decision Making using costing	8 hours

Marginal Costing -Cost Volume Profit Analysis-Budgets			
Lab Experiments : Not Applicable			
		Total Lecture hours:	**45 hours**
Text Book(s)			
1.	Robert N Anthony, David Hawkins, Kenneth Marchant, Accounting: Texts and Cases, McGraw-Hill		
2.	Case Study Materials: To be distributed for class discussion		
Reference Books			
1.	Advanced Accounting by RL Gupta and Radhaswamy		
2.	Advanced Accounting by MC Shukla and Grewal		
Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**20-05-2020**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course Code	Course Title	L	T	P	J	C
MGT 1065	Fundamentals of Management	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives: To develop the ability to

1. Understand management theories, evolution of management over the years and basics concepts of Management.
2. Develop an understanding about how organizations work
3. Exlpore the intricacies of different management areas such as finance, marketing, strategy etc

Expected Course Outcome:

1. Understanding of the basic theoretical concepts of Management and Organisational Behaviour
2. Understanding and linking the concepts with contemporary issues
3. Understand real-time management problems, analyse them, and find solutions
4. Develop and exhibit cross-cultural competencies by working in teams.
5. Develop managerial skills needed to become an effective manager.

Module:1	Management Theories	8 hours

Concept and Foundations of Management, Evolution of Management Thoughts [Pre-Scientific Management Era (before 1880), Classical management Era (1880-1930), Neo-classical Management Era (1930-1950), Modern Management era (1950-on word). Contribution of Management Thinkers: Taylor, Fayol, Elton Mayo etc.

Module:2	Functions of Management	6 hours

Planning, Organizing, Staffing, Directing, Controlling

Module:3	Organization Behavior	6 hours

Introduction, Personality, Perception, Learning and Reinforcement, Work Stress and Stress Management, Decision Making, Problems in Decision Making, Decision Making

Module:4	Organizational Design	6 hours

Classical, Neoclassical and Contingency approaches to organizational design; Organizational theory and design, Organizational structure (Simple Structure, Functional Structure, Divisional Structure, Matrix Structure)

Module:5	Motivation &Organisational culture	6 hours

Motivation, Group Dynamics, Power & Influence, Organizational Culture, Managing Cultural Diversity

Module:6	Managerial Ethics	6 hours

Ethics and Business, Ethics of Marketing & advertising, Ethics of Finance & Accounting, Decision – making frameworks, Business and Social Responsibility, International Standards, Corporate Governance, Corporate Citizenship, Corporate Social Responsibility

Module:7	Leadership	5 hours

Concept, Nature, Importance, Attributes of a leader, developing leaders across the organization, Leadership Grid

Module:8	**Contemporary issues**	**2 hours**
Contemporary issues in Management		
Lab Experiments : NIL		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Richard L. Daft, Understanding the Theory and Design of Organizations
2.	Stephen P. Robbins, Timothy A. Judge, Neharika Vohra, Organizational Behavior
3.	Harold Koontz, Essentials of Management
Reference Books	
1.	Cyril J. O'Donnell and Harold Koontz, Principles of Management: An Analysis of Managerial Functions
2.	Arnold Bakker, Positive Interventions in Organizations
3.	Journals- Academy of Management Journal, Journal of Management, HBR

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**16-02-2019**		
Approved by Academic Council	**No. 55**	**Date**	**13-06-2019**

Course Code	Course Title	L	T	P	J	C
MGT2002	Marketing Research & Marketing Management	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. Explore and understand the need of study of Marketing and Marketing Research
2. Apply the acquired skill into real world problems
3. Utilize marketing management tools for competitive advantage

Expected Course Outcome:

1. Understand basic marketing concepts
2. Comprehend the dynamics of marketing and analyze how its various components interact with each other in the real world
3. Leverage marketing concepts for effective decision making
4. Understand basic concepts and application of statistical tools in marketing research

Module:1	Marketing Concepts	8 hours

Marketing Concepts and Applications: Introduction to Marketing & Core Concepts, Marketing of Services, Importance of marketing in service sector. Marketing Planning & Environment: Elements of Marketing Mix, Analyzing needs & trends in Environment - Macro, Economic, Political, Technical & Social Understanding the consumer: Determinants of consumer behavior, Factors influencing consumer behavior.Market Segmentation: Meaning & Concept, Basis of segmentation, selection of segments, Market Segmentation strategies, Target Marketing, Product Positioning

Module:2	Product Decisions	6 hours

Product Management: Product Life cycle concept, New Product development & strategy, Stages in New Product development, Product decision and strategies, Branding & packaging

Module:3	Price, Place and Promotion Decisions	6 hours

Pricing, Promotion and Distribution Strategy: Policies & Practices – Pricing Methods & Price determination Policies. Marketing Communication – The promotion mix, Advertising & Publicity, 5 M's of Advertising Management. Marketing Channels, Retailing, Marketing Communication, Advertising.

Module:4	Marketing Research	6 hours

Marketing Research: Introduction, Type of Market Research, Scope, Objectives & Limitations Marketing Research Techniques, Survey Questionnaire design & drafting, Pricing Research, Media Research, Qualitative Research.

Module:5	Marketing Research & Data Analysis	6 hours

Marketing Research & Data Analysis: Use of various statistical tools – Descriptive & Inference Statistics, Statistical Hypothesis Testing, Multivariate Analysis - Discriminant Analysis, Cluster Analysis, Segmenting and Positioning, Factor Analysis.

Module:6	Internet Marketing	6 hours

Internet Marketing: Introduction to Internet Marketing. Mapping fundamental concepts of Marketing (7Ps, STP); Strategy and Planning for Internet Marketing.		
Module:7	**B2B Marketing**	**5 hours**
Business to Business Marketing: Fundamental of business markets. Organizational buying process. Business buyer needs. Market and sales potential. Product in business markets. Price in business markets. Place in business markets. Promotion in business markets. Relationship, networks and customer relationship management. Business to Business marketing strategy.		
Module:8	**Contemporary issues**	**2 hour**
Contemporary topics in marketing		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Marketing Management (2019), Philip Kotler & Keller Kevin,4th edition, Pearson education
2.	Marketing Management (2019), Deepak, R. Kanthiah Alias, and S. Jeyakumar, Educreation Publishing
3.	Marketing Management: A relationship approach (2019), Hollensen, S, Pearson Education.
4.	Marketing research: An applied approach (2019), Malhotra, N. K., Nunan, D., & Birks, D. F. ,Pearson Education Limited.
Reference Books	
1.	Marketing research: Text and cases (2020), Nargundkar, R, McGraw-Hill Education.
2.	Marketing management: A cultural perspective (2020), Visconti, L. M., Peñaloza, L., & Toulouse, N. (Eds.) Routledge.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
MGT2003	Financial Management	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. Understand the fundamental concepts of financial management
2. Appreciate basic concepts such as time value of money, cost of capital, risk and return, working capital management, capital budgeting etc.
3. Leverage the concept for deciding financial angle of IT projects

Expected Course Outcome:

Students will be able to:

1. To enable the budding Technocrat Managers to understand the Financial Management concepts and to appreciate the concepts of "time value of money" in the decision-making process.
2. To value the Securities and know the concept of Risk and return
3. To evaluate the "Leverage" , "cost of capital" and the projects using the Capital budgeting concepts
4. To understand the Capital components, their implications and Working Capital requirements.
5. To analytically view the Components of Working Capital.

Module:1	Introduction	2 hours

Introduction: Introduction to Financial Management - Goals of the firm - Financial Environments. **Time Value of Money:** Simple and Compound Interest Rates, Amortization, Computing more than once a year, Annuity Factor.

Module:2	Valuation of Securities / Risk & return	10 hours

Valuation of Securities: Bond Valuation, Preferred Stock Valuation , Common Stock Valuation, Concept of Yield and YTM.

Risk & Return: Defining Risk and Return, Using Probability Distributions to Measure Risk, Attitudes Toward Risk, Risk and Return in a Portfolio Context, Diversification, The Capital Asset Pricing Model (CAPM)

Module:3	Leverage / Cost of Capital	6 hours

Operating & Financial Leverage: Operating Leverage, Financial Leverage, Total Leverage, Indifference Analysis in leverage study**Cost of Capital**: Concept , Computation of Specific Cost of Capital for Equity - Preference – Debt, Weighted Average Cost of Capital – Factors affecting Cost of Capital.

Module:4	Capital budgeting	4 hours

The Capital Budgeting Concept & Process - An Overview, Generating Investment Project Proposals, Estimating Project, After Tax Incremental Operating Cash Flows, Capital Budgeting Techniques, Project Evaluation and Selection - Alternative Methods

Module:5	Working Capital Management:	3 hours

Overview, Working Capital Issues, Financing Current Assets (Short Term and Long Term- Mix), Combining Liability Structures and Current Asset Decisions, Estimation of Working Capital

Module:6	**Cash Management:**	**9 hours**
Motives for Holding cash, Speeding Up Cash Receipts, Slowing Down Cash Payouts, Electronic Commerce, Outsourcing, Cash Balances to maintain, Factoring		
Module:7	**Accounts Receivable Management:**	**11 hours**
Credit & Collection Policies, Analyzing the Credit Applicant, Credit References, Selecting optimum Credit period.		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Chandra, Prasanna - Financial Management - Theory & Practice, Prentice Hall/Pearson Education. (2019)
2.	I.M. Pandey, Financial Management, Vikas Publishing House (2016)

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
MGT3016	Services Science and Service Operations Management	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. This course examines the management of services focusing on both the strategic and operational aspects of designing new services
2. Helps in assessing and improving service quality, improving the efficiency and effectiveness of service processes
3. Helps in understanding the integration of new technologies into service operations.

Expected Course Outcome:

1. To understand concepts about Services and distinguish it from Goods
2. To identify characteristics and nature of Services
3. Comprehend ways to design Services and evaluate them using Service qualities
4. To be able to understand various methods to be used to operate and manage Service businesses
5. To understand how innovation can be approached from Services point of view
6. To be familiar with the tools and techniques used for designing and managing the service operations.

Module:1	Introduction to services	4 hours

Introduction to the course, introduction to service operations, role of service in economy and society, introduction to Indian service sector, differences between services and operations, service package, characteristics, various frameworks to design service operation system, kind of service encounter, importance of encounters

Module:2	Service Design	5 hours

Service-Dominant Logic, Goods-Dominant logic to Service-Dominant logic, Value Co-creation, Customer Journey and Service Design, Design Thinking methods to aid Service Design, Development of Strategic Service Vision (SSV), Data Envelopment Analysis, NSD cycle, Service Blueprinting, Elements of service delivery system

Module:3	Quality and Yield Management	4 hours

Models of facility locations (Huff's retail model), role of service-scape in layout design, SERVQUAL, walk through audit, dimensions of service quality & other quality tools

Module:4	Service Guarantee & Service Recovery	4 hours

Service guarantee, benefits, types, design of service of guarantees, service failure, service recovery, strategy, customer response analysis.

Module:5	Forecasting, Managing Capacity and facilities	4 hours

Forecasting Demand for Services, review of different types of forecasting methods, managing capacity and demand: Strategies for matching capacity and demand, psychology of waiting, application of various tools used in managing waiting line in services, managing facilitating Goods, review of inventory models, role of inventory in services

Module:6	**Service Supply, Queuing Models**	**4 hours**
Managing service supply relationship: Understanding the supply chain/hub of service, Strategies for managing suppliers of service, Vehicle Routing Problem: Managing after sales service, Understanding services that involve transportation of people and vehicle, Techniques for optimizing vehicle routes		
Module:7	**Service Innovation**	**3 hours**
Services Productivity, Need for Services Innovation, Case studies,		
Module:8	**Contemporary issues**	**2 hours**
Expert lecture on recent trends		
	Total lecture hours	**30 hours**

Text Book

1.	Fitzsimmons & Fitzsimmons, Service Management: Operations, Strategy, Information Technology, 2019, 9th edition, McGraw Hill publications.

Reference Books

1.	Wilson, A., Zeithaml, V. A., Bitner, M. J., &Gremler, D. D. Services marketing: Integrating customer focus across the firm. 2012. McGraw Hill publications.
2.	Reason, Ben, and Lovlie, Lavrans, Service Design for Business: A Practical Guide to Optimizing the Customer Experience, 2016, Pan Macmillan India.

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

List of Experiments

1.	Design a new super market in a cosmopolitan city (Identify important attributes, specify attribute levels, experimental design, presentation of alternatives to respondents and estimation of choice model)	4 hours
2.	Choose any service organization and present it from the perspective of nature of service, classification of service, blueprint or service design analysis, and service quality.	4 hours
3.	Prepare a service blueprint for a fast food outlet.	2 hours
4.	Using data, software, user and mashup as services prepare a next gen service oriented architecture.	4 hours
5.	Prepare a review article after analysing 5 relevant papers in services and explain your understanding and feedback on the same.	4 hours
6.	Analyse a fortune 500 company in digital media and point out how these technologies could be effectively used in a startup in digital space.	4 hours
7.	Analyse the booking policy of an international flight operator, assuming that the average number of no shows is 10%, explain why the best overbooking necessary isn't be 10% always.	4 hours
8.	Prepare a comparative chart analysing any four food delivery agencies and rank them based on reliability, responsiveness, assurance, and empathy.	4 hours
	Total Hours	**30Hours**

Mode of Evaluation: Assessments/Midterm Lab/ FAT

Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**19-07-2021**

PROGRAMME ELECTIVE

(2019 - 2020)

B. Tech. Computer Science and Engineering and Business Systems

(in collaboration with TCS)

Course Code	Course Title	L	T	P	J	C
CBS3005	Cloud Microservices and Applications	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To Understand fundamentals of cloud computing
2. To acquire good working knowledge of the essentials of Cloud Micro Services
3. To implement business specific cloud applications

Expected Course Outcome:

1. Study the basics of cloud computing, cloud models and its applications.
2. Understand cloud services and architecture.
3. Learn how to use Cloud Services and to build applications.
4. Realize security needs for cloud service and Analyze different SLAs
5. Analyze platform-specific security features and management of security controls.
6. Design, Develop & Deploy real-world applications in the cloud computing platforms

Module:1	**Cloud Fundamentals**	**4 Hours**

Cloud Service Components - Deployment Models – Application of Cloud Computing

Module:2	**Application Architectures**	**6 Hours**

Monolithic and Distributed – Micro Service fundamentals – Design Approach – Cloud Native Application – Application Integration Process – API fundamental – API Management

Module:3	**Cloud Services**	**8 Hours**

Application Services - Deployment and Management Services - Amazon Web Services - Windows Azure

Module:4	**Cloud Application Development**	**8 Hours**

Python-Refresher, Use cases

Module:5	**Cloud Security**	**6 Hours**

Security Basics and Benefits – Challenges

Module:6	**Cloud Service Monitoring and Management**	**5 Hours**

Cloud Security Monitoring Tools

Module:7	**Case Studies**	**6 hours**

Azure features use cases - GCP Features Use cases - AWS features use cases

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

Contemporary issues in cloud computing

Total Lecture hours:	**45 Hours**

Lab Experiments

1.	Develop cloud application using Amazon Cloud, Google Cloud.	5 Hours
2.	Demonstrate cloud application using Windows Azure.	5 Hours

3.	Implementation of Amazon cloud services.	5 Hours
4.	Patient Health Monitoring using AWS/Windows Azure.	5 Hours
5.	Financial Trading Monitoring System using AWS/Windows Azure.	5 Hours
6.	Cloud Usecase resource monitoring using AWS/Windows Azure.	5 Hours
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing Principles and Paradigms, 1st Edition, Wiley, 2013.
2.	Ronald Krutz and Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley, 2010.
Reference Books	
1.	Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach, McGraw Hill, 2010.
2.	Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Helper, Cloud Computing For Dummies, Wiley, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS3006	Machine Learning	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. Ability to comprehend the concept of supervised and unsupervised learning techniques
2. Differentiate regression, classification and clustering techniques and to implement their algorithms.
3. To analyze the performance of various machine learning techniques and to select appropriate features for training machine learning algorithms.

Expected Course Outcome:

1. Understand the concepts of various machine learning strategies.
2. Handle computational data and learn ANN learning models.
3. Solve real world applications by selecting suitable learning model.
4. Boost the performance of the model by combining results from different approaches.
5. Recognize and classify sequencing patterns using HMM.
6. Infer the association and relationship between the data objects.
7. Construct machine learning model for unseen data and can solve real world application.

Module:1	Introduction to Machine Learning	3 hours

Introduction to Machine Learning (ML); Feature engineering; Learning Paradigm, Generalization of hypothesis, VC Dimension, PAC learning, Applications of ML.

Module:2	Data Handling and ANN	4 hours

Feature selection Mechanisms, Imbalanced data, Outlier detection- Artificial neural networks including backpropagation- Applications

Module:3	ML Models and Evaluation	6 hours

Regression: Multi-variable regression; Model evaluation; Least squares regression; Regularization; LASSO; Applications of regression, Classification – KNN, Naïve Bayes, SVM, Decision Tree; Training and testing classifier models; Cross-validation; Model evaluation (precision, recall, F1-mesure, accuracy, area under curve); Statistical decision theory including discriminant functions and decision surfaces

Module:4	Model Assessment and Inference	4 hours

Model assessment and Selection – Ensemble Learning – Boosting, Bagging, Model Inference and Averaging, Bayesian Theory, EM Algorithm

Module:5	Hidden Markov Models	3 hours

Hidden Markov Models (HMM) with forward-backward and Vierbi algorithms; Sequence classification using HMM; Conditional random fields; Applications of sequence classification such as part-of-speech tagging

Module:6	Association Rules	3 hours

Mining Association Rules in Large Databases. Mining Frequent Patterns-- basic concepts - Efficient and scalable frequent item set mining -methods, Apriori algorithm, FP-Growth algorithm		
Module:7	**Clustering**	**5 hours**
K Means, Hierarchical Clustering – Single, complete, Average linkage; Ward's algorithm; Minimum spanning tree clustering; BIRCH clustering		
Module:8	**Recent Trends**	**2 hours**
Recent Trends and case study		
	Total Lecture hours:	**30 hours**

Lab 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	2 hours
7.	Implement K-means Clustering to Find Natural Patterns in Data	2 hours
8.	Implement Hierarchical clustering	2 hours
9.	Implement K-mode clustering	2 hours
10	Implement Association Rule Mining using FP Growth	2 hours
11.	Classification based on association rules	2 hours
12.	Implement Gaussian Mixture Model Using the Ex ectation Maximization	2 hours
13	Evaluating ML algorithm with balanced and unbalanced datasets	2 hours
14	Comparison of Machine Learning algorithms	2 hours
15	Implement k-nearest neighbour algorith	2 hours
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Pearson, Third Edition, 2014.
2.	Friedman Jerome, Trevor Hastie, and Robert Tibshirani. The Elements of Statistical Learning. Springer-Verlag, 2nd Edition, 2013.
Reference Books	
1.	Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2.	Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS3007	Data Mining and Analytics	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To introduce the fundamental processes data warehousing and major issues in data mining
2. To impart the knowledge on various data mining concepts and techniques that can be applied to text mining, web mining etc.
3. To develop the knowledge for application of data mining and social impacts of data mining.

Expected Course Outcome:

1. Interpret the contribution of data mining to the decision-support systems.
2. Prepare the data needed for data mining using preprocessing techniques and apply the various visualization techniques.
3. Discover interesting patterns from large amounts of data using Association Rule Mining
4. Extract useful information from the labeled data using various classifiers and Predictors
5. Compute forecasts for a variety of linear methods and models
6. Demonstrate capacity to perform a self-directed piece of practical work that requires the application of data mining techniques.

Module:1	Introduction to Data Mining	3 hours

Datamining-Introduction- Related technologies - Machine Learning, DBMS, OLAP, Statistics, Stages of the Data Mining Process, Data Mining Techniques, Knowledge Representation Methods, Applications

Module:2	Data preprocessing	5 hours

Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Installing Weka 3 Data Mining System, Experiments with Weka - filters, discretization

Module:3	Data mining knowledge representation	4 hours

Task relevant data, Background knowledge, Representing input data and output knowledge, Visualization techniques; Attribute-oriented analysis: Attribute generalization, Attribute relevance, Class comparison, Statistical measures

Module:4	Data mining algorithms - Association rules	4 hours

Motivation and terminology, Example: mining weather data, Basic idea: item sets, generating item sets and rules efficiently, Efficient and scalable frequent item set mining methods: Apriori algorithm, FP-Growth algorithm, Correlation analysis

Module:5	Data mining algorithms – Classification & Prediction	5 hours

Basic learning/mining tasks, inferring rudimentary rules: 1R, algorithm, Decision trees, covering rules; Prediction: The prediction task, Statistical (Bayesian) classification, Bayesian networks, Instance-based methods (nearest neighbor), linear models

Module:6	Forecasting models	11 hours

Descriptive analytics: Data Modeling, Trend Analysis, Simple Linear Regression Analysis

Forecasting models: Heuristic methods, predictive modeling and pattern discovery, Logistic Regression: Logit transform, ML estimation, Tests of hypotheses, Wald test, LR test, score test, test for overall regression, multiple logistic regression, forward, backward method, interpretation of parameters, relation with categorical data analysis. Interpreting Regression Models, Implementing Predictive Models.

Generalized Linear model: link functions such as Poisson, binomial, inverse binomial, inverse Gaussian, Gamma.

Module:7	**Time Series Analysis**	**11 hours**

Time Series Analysis: Auto - Covariance, Auto-correlation and their properties. Exploratory time series analysis, Test for trend and seasonality, Exponential and moving average smoothing, Holt – Winter smoothing, forecasting based on smoothing

Linear time series models: Autoregressive, Moving Average, Autoregressive Moving Average and Autoregressive Integrated Moving Average models; Estimation of ARMA models such as Yule-Walker estimation for AR Processes, Maximum likelihood and least squares estimation for ARMA Processes, Forecasting using ARIMA models

Prescriptive Analytics: Mathematical optimization, Networks modeling-Multi-objective optimization-Stochastic modeling, Decision and Risk analysis, Decision trees.

Module:8	**Contemporary issues**	**2 hours**
Recent trends in Data mining		
Total Lecture hours:		**45 hours**

Text Book(s)

1.	Ian H. Witten, Eibe Frank, and Mark A. Hall, Christopher Pal, "Data Mining: Practical Machine Learning Tools and Techniques" Morgan Kaufmann Publishers, 4th Edition, 2017
2.	George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung. "Time Series Analysis, Forecasting and Control", John Wiley, 5th Edition, 2015

Reference Books

1.	Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 3rd Edition 2012.
2.	A. Colin Cameron and Pravin K. Trivedi, "Regression Analysis of Count Data", Cambridge University Press, 2nd Edition, 2013

Lab	**Experiments**	**Hours**
1.	Create a Weather Table with the help of WEKA tool	2 hours
2.	Apply Pre-Processing techniques to the training data set of Weather Table	2 hours
3.	Normalize Weather Table data using Knowledge Flow	2 hours
4.	Implement A-priori algorithm	2 hours
5.	Implement FP Growth algorithm	2 hours
6.	Implement Decision Tree learning.	2 hours
7.	Implement Logistic Regression.	2 hours
8.	Implement classification using Multilayer perceptron.	2 hours
9.	Implement Bagging using Random Forests	2 hours

10.	Implement Bayesian networks	2 hours
11.	Implement k-nearest neighbors algorithm	2 hours
12.	Build statistical models using any linear regression technique	2 hours
13.	Build statistical models using Nonlinear regression technique	2 hours
14.	Build statistical models using Logistic regression	2 hours
15.	Perform forecast analysis using ARIMA model	2 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18.02.2021**

Course Code	Course Title	L	T	P	J	C
CBS3008	Introduction to Internet of Things	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To understand basic principles and concepts of Internet-of-Things use cases, applications, architecture and technologies.
2. To get an overview of an end to end IoT system encompassing the edge, cloud and application tiers.

Expected Course Outcome:

1. Understand basic principles and concepts of Internet-of-Things use cases, applications.
2. Understand basic concepts of Architecture of IoT.
3. Describe Sensor and Industrial systems.
4. Understand Networking and communication for IoT.
5. Comprehend IoT data processing and storage.
6. Demonstrate IoT applications in various domains using prototype models.

Module:1	Introduction to IoT and Use cases	3 hours

Understanding basic concepts of IoT, Consumer IoT vs Industrial Internet, Fundamental building blocks, Use Cases of IoT in various industry domains.

Module:2	Architecture	6 hours

IoT reference architectures, Industrial Internet Reference Architecture, Edge Computing, IoT Gateways, Data Ingestion and Data Processing Pipelines, Data Stream Processing.

Module:3	Sensors	6 hours

Introduction to sensors and transducers, integrating sensors to sensor processing boards.

Module:4	Industrial Systems	6 hours

Introduction to industrial data acquisition systems, industrial control systems and their functions.

Module:5	Networking and Communication for IoT	7 hours

Recap of OSI 7 layer architecture and mapping to IoT architecture, Introduction to proximity networking technologies (ZigBee, Bluetooth, Serial Communication)

Module:6	Network protocols	8 hours

Industrial network protocols (Modbus, CANbus), Communicating with cloud applications (web services, REST, TCP/IP and UDP/IP sockets, MQTT, WebSockets, protocols. Message encoding (JSON, Protocol Buffers).

Module:7	IoT Data Processing and Storage	7 hours

Time Series Data and their characteristics, time series databases, basic time series analytics, data summarization and sketching, dealing with noisy and missing data, anomaly and outlier detection.

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

Text Book(s)			
1.	Samuel Greengard , The Internet of Things, MIT Press Essential Knowledge Series, 2015		
Reference Books			
1.	Ben Fry, Visualizing Data-Exploring and Explaining Data with the Processing Environment, O'Reilly Media, 2008.		
2.	Andrew K Dennis , Raspberry Pi Computer Architecture Essentials, Packt Publishing, 2016		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Lab Experiments			
1.	Setting up the Arduino Development Environment, connecting analog sensors to an Arduino Boarding and reading analog sensor data		3 hours
2.	Digital Input and Output reading using and Arduino board and Arduino Development Environment		3 hours
3.	Integrate an Arduino Board to a Raspberry Pi computer and send sensor data from Arduino to the R Pi		3 hours
4.	Setup Python on the R Pi and run sample R Pi programs on the R Pi. Read the data from Arduino using Python language		3 hours
5.	Connect a R Pi Camera module to the Raspberry Pi and using Python programming capture still images and video		3 hours
6.	Set up TCP/IP socket server on a PC. Send a message from the R Pi to the PC using socket communication		3 hours
7.	Set up a MQTT broker on the PC. Send data from R Pi to PC using MQTT protocol. Receive data from PC to R Pi using MQTT protocol		3 hours
8.	Connect LED lights to an Arduino. Connect the Arduino to the R Pi. Send Message from PC to R Pi via MQTT protocol. On receipt of the message , toggle the LED lights on the Arduino		3 hours
9.	Set up an account in a cloud service (such as Google / AWS or Azure). Set up a simple Http server using a language of your choice. Push the image captured from the R Pi camera to this web service. On receiving the image, store the image in a database or file		3 hours
10.	Develop a mobile application to view the images captured by the R Pi camera		3 hours
		Total Laboratory Hours	**30 hours**
Mode of evaluation: Project/Activity			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course code	Course Title	L	T	P	J	C
CBS3009	Advanced Social, Text and Media Analytics	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To introduce the various tools for Text Mining and carry out Pattern Discovery, Predictive Modelling.
2. To Explore the use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales
3. To Perform social media analytics to identify important social actors, subgroups and network properties in social media sites.

Expected Course Outcome:

1. Interpret the contribution of text mining to generate new knowledge from natural language text
2. Extract useful information from the textual data using various classifiers and Predictors
3. Identify the various components of a web that can be used for mining process
4. Analyse social media data using appropriate web mining techniques
5. Discover interesting patterns from Social Media Networks using linear methods and models
6. Provide solutions to the emerging problems of social media analytics with sentiment analysis and opinion mining

Module:1	Introduction to Text Mining	5 hours

Introduction to Text Mining - Text Representation- Core text mining operations - Text mining applications

Module:2	Text Mining Essentials	6 hours

Text mining Preprocessing techniques - Text Clustering, Text Classification, Topic Modelling, Probabilistic models for information extraction

Module:3	Web Mining	5 hours

Web Analytics - Web analytics tools, Clickstream analysis, A/B testing, online surveys; Web search and retrieval

Module:4	Web Analytics Essentials	6 hours

Search engine optimization, Web crawling and Indexing, Ranking algorithms, Web traffic models

Module:5	Social Media Networks	6 hours

Social network and web data and methods. Graphs and Matrices. Basic measures for individuals and networks. Information visualization.

Module:6	Social Media Analytics	7 hours

Making connections: Link analysis. Random graphs and network evolution. Social contexts: Affiliation and identity; Social network analysis

Module:7	Sentiment Analysis and Opinion Mining	8 hours

Content Analysis; Natural Language Processing; Clustering & Topic Detection; Simple Predictive Modeling; Sentiment Analysis; Sentiment Prediction

Module:8	**Industry Expert Lecture**	**2 hour**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Bing Liu, Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data, Springer, Second Edition, 2011.
2.	Reza Zafarani, Mohammad Ali Abbasi and Huan Liu, Social Media Mining-An Introduction, Cambridge University Press, 2014.
Reference Books	
1.	Bing Liu, Sentiment Analysis: Mining Opinions, Sentiments, and Emotions, Cambridge University Press, Second Edition, 2020.
2.	Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, First Edition, 2009.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS3010	Mobile Computing	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To learn about various wireless & cellular communication networks and various telephone and satellite networks.
2. To build knowledge on various Adhoc and sensor networks routing protocol and energy efficient protocol.
3. To build skills in working with Cognitive radio networks and recent telecommunication networks
4. To design and development of various network protocol using simulation tools.

Expected Course Outcome:

After successfully completing the course, the student should be able to

1. Understand the working principles of mobile networks and Contrast different types of telecommunication networks.
2. Study on location, handoff management and wireless fundamentals.
3. Study on MANET and Sensor networks including architecture, routing and power optimization technique.
4. Study on cognitive ratio networks and its applications.
5. Assess the recent telecommunication networks, resource management
6. Design & development of various wireless network protocols using simulation tools

Module:1	Introduction	7 hours

Overview of wireless and mobile infrastructure; Preliminary concepts on cellular architecture; Design objectives and performance issues; Radio resource management and interface; Propagation and path loss models; Channel interference and frequency reuse; Cell splitting; Channel assignment strategies; Overview of generations:- 1G to 5G.

Module:2	Location and handoff management	8 hours

Introduction to location management (HLR and VLR); Mobility models characterizing individual node movement (Random walk, Fluid flow, Markovian, Activity based); Mobility models characterizing the movement of groups of nodes (Reference point-based group mobility model, Community based group mobility model); Static (Always vs. Never update, Reporting Cells, Location Areas) and Dynamic location management schemes (Time, Movement, Distance, Profile Based); Terminal Paging (Simultaneous paging, Sequential paging); Location management and Mobile IP; Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).

Module:3	Wireless transmission fundamentals	7 hours

Introduction to narrow and wideband systems; Spread spectrum; Frequency hopping; Introduction to MIMO; MIMO Channel Capacity and diversity gain; Introduction to OFDM; MIMO-OFDM system; Multiple access control (FDMA, TDMA, CDMA, SDMA); Wireless local area network; Wireless personal area network (Bluetooth and zigbee).

Module:4	**Mobile Ad-hoc networks**	**4 hours**
Characteristics and applications; Coverage and connectivity problems; Routing in MANETs.		
Module:5	**Wireless sensor networks**	**5 hours**
Concepts, basic architecture, design objectives and applications; Sensing and communication range; Coverage and connectivity; Sensor placement; Data relaying and aggregation; Energy consumption; Clustering of sensors; Energy efficient Routing (LEACH).		
Module:6	**Cognitive radio networks**	**5 hours**
Fixed and dynamic spectrum access; Direct and indirect spectrum sensing; Spectrum sharing; Interoperability and co-existence issues; Applications of cognitive radio networks.		
Module:7	**D2D communications in 5G cellular networks**	**7 hours**
Introduction to D2D communications; High level requirements for 5G architecture; Introduction to the radio resource management, power control and mode selection problems; Millimeter wave communication in 5G.		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Jochen Schiller, Mobile Communications. Pearson Education, 2009.
2. Andrea Goldsmith, Wireless Communications. Cambridge University Press, 2012.

Reference Books

1. Ivan Stojmenovic, Handbook of Wireless Networking and Mobile Computing, Wiley, 2002.
2. Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan Mandayam and H. Vincent Poor, Principles of Cognitive Radio. Cambridge University Press, 2012.

Lab Experiments

Design and Development of different wireless network protocols using network simulators such as NS-3 / OMNET++.

1	MAC Protocol	4 Hours
2	Routing Protocol	4 Hours
3	Transport Protocol	6 Hours
4	Congestion Control Protocol	6 Hours
5	Application Protocol	6 Hours
6	Security Protocol	6 Hours
	Total hours	**30 Hours**

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS3013	Conversational Systems	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. Enable attendees to acquire knowledge on chatbots and its terminologies
2. Work with machine learning concepts and different algorithms to build custom model.
3. Understand on conversational experiences and provide better customer experiences

Expected Course Outcome:

1. Understand the fundamentals of conversational systems and foundational blocks of programming.
2. Apply the natural language processing techniques in building conversational systems.
3. Design and build chatbots and conversational intelligent systems.
4. Analyse the significance of machine learning methods and artificial intelligence in conversational technologies.
5. Perform the analytics on conversational systems using performance metrics.

Module:1	Fundamentals of Conversational Systems	6 hours

Introduction: Overview, Case studies, Explanation about different modes of engagement for a human being, History and impact of AI. Underlying technologies: Natural Language Processing, Artificial Intelligence and Machine Learning, NLG, Speech-To-Text, Text-To-Speech, Computer Vision etc. Introduction to Top players in Market – Google, MS, Amazon &Market trends. Messaging Platforms (Facebook, WhatsApp) and Smart speakers – Alexa, Google Home and other new channels. Ethical and Legal Considerations in AI Overview.

Module:2	Foundational Blocks for Programming	2 hours

Basic Python programming concepts, Node Basics, Coding Best Practices, Evaluation Test.

Module:3	Natural Language Processing	12 hours

Introduction: Brief history, Basic Concepts, Phases of NLP, Application of chatbots etc. General chatbot architecture, Basic concepts in chatbots: Intents, Entities, Utterances, Variables and Slots, Fulfilment, Lexical Knowledge Networks (WordNet, Verbnet, PropBank, etc.). Lexical Analysis, Part-of-Speech Tagging, Parsing/Syntactic analysis, Semantic Analysis, Word Sense Disambiguation. Information Extraction, Sentiment Analysis, NLP using Python - Make use of any of the NLP libraries like NLTK, spaCy, StanfordNLP etc., Affective NLG.

Module:4	Building a chatbot/Conversational AI Systems	10 hours

Fundamentals of Conversational Systems (NLU, DM and NLG). Chatbot framework & Architecture, Conversational Flow & Design, Intent Classification (ML and DL based techniques), Dialogue Management Strategies, Natural Language Generation.UX design, APIs and SDKs, Usage of Conversational Design Tools. Introduction to popular chatbot frameworks – Google Dialog flow, Microsoft Bot Framework, Amazon Lex, RASA Channels: Facebook Messenger, Google Home, Alexa, WhatsApp, Custom Apps.Overview of CE Testing techniques, A/B Testing, Introduction to Testing Frameworks - Botium /Mocha, Chai.Security & Compliance – Data Management, Storage, GDPR,

PCI.Building a Voice/Chat Bot, Case Study		
Module:5	**Role of ML/AI in Conversational Technologies**	**6 hours**
Understanding on how Conversational Systems uses ML technologies in ASR, NLP, Advanced Dialog management, Language Translation, Emotion/Sentiment Analysis, Information extraction, etc. to effectively converse. Case Study.		
Module:6	**Contact Centres**	**4 hours**
Introduction to Contact centres – Impact & Terminologies, Case studies & Trends, Scope of a Virtual Agent/Assistant in contact centre		
Module:7	**Overview on Conversational Analytics**	**3 hours**
Conversation Analytics: The need of it ,Introduction to Conversational Metrics, Summary, Robots and Sensory Applications overview,XR Technologies in Conversational Systems , XR-Commerce, Future technologies and market innovations overview.		
Module:8	**Recent Trends**	**2 hours**
Guest lecture by Industry experts		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Micheal McTear, Conversational AI: Dialogue Systems, Conversational Agents and chatbots, 2020, 1st Edition, Morgan and Claypool.
2.	Luis Fernando D Haro, Zoraida Callejas, Satosh Nakamura, Conversational Dialogue Systems for the Next Decade, 2021,1st Edition, Springer.

Reference Books

1.	Srini Janarthanam, Chatbots and Conversational UI Development, 2017, 1stEdition, Packt Publishers.
2.	Diana Perez-marin and Ismael Pascual-Nieto, Conversational Agents And Natural Language Interaction, 2011, 1stEdition, IGI Global publishers.

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

List of Experiments

1.	Study of basics of python programming related to conversational AI	3 Hours
2.	Implementation of lexical analysis	3 Hours
3.	Implementation of syntactic analysis	3 Hours
4.	Implementation of Sentimental Analysis	3 Hours
5.	Implementation of natural language processing using python libraries.	3 Hours
6.	Testing of chatbot frameworks	3 Hours
7.	Implementation of voice bots	3 Hours
8.	Implementation of a generic chat bot	3 Hours
9.	Implementation of a bot for a class room discussion application.	3 Hours
10.	Implementation of a bot for a simple medical diagnosis application.	3 Hours
	Total Laboratory hours	**30 Hours**

Mode of assessment: Assessments/Midterm Exam/FAT

Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**16-07-2021**

Course Code	Course Title	L	T	P	J	C
CBS3014	Modern Web Applications	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To comprehend and analyse the basic concepts of web programming and internet protocols.
2. To describe how the client-server model of Internet programming works.
3. To demonstrates the uses of scripting languages and their limitations.

Expected Course Outcome:

1. Differentiate web protocols and web architecture.
2. Apply HTML and CSS effectively to create interactive websites.
3. Implement client-side scripting using JavaScript to design dynamic websites.
4. Develop XML based web applications.
5. Implement server-side scripting using PHP.
6. Design PHP application with Database connectivity.

Module:1	Introduction to Internet & World Wide Web	4 hours

History of the Internet & World- Wide Web, Web Browsers, Web Servers, Uniform Resource Locator, Tools and Web Programming Languages. Web Standards, Categories of Web Applications, Characteristics of Web Applications, Tiered Architecture

Module:2	Hypertext Mark Up Language (HTML) and Cascading Style Sheets (CSS)	6 hours

Basic HTML page, Text Formatting, Table, Headers, Linking, Images, List, Meta Elements, Cascading Style Sheets: Inline, Internal and External Style Sheet, Bootstrap - CSS Text, CSS forms, CSS components drop down

Module:3	Java Script	8 hours

Introduction to Java Scripts, Objects in Java Script, Dynamic HTML with Java Script, Bootstrap - JS Alert, JS Button, JS popover, Document Object Model (DOM) with JavaScript

Module:4	Extensible Markup Language (XML)	6 hours

Introduction, Structuring Data, Document Type Definition, XML Vocabularies, Extensible Stylesheet Language Transforms (XSL)

Module:5	Basic PHP Programs	6 hours

Introduction to PHP, Numbers and Strings, Literals and Variables, Operators and Functions, arrays.

Module:6	Server-Side Processing	7 hours

Creating Form Controls, Using Values Returned From, Forms Using PHP - User Authentication: Creating Session, Authorization Level.

Module:7	PHP Database Connectivity and Manipulating Data	6 hours

Connecting to MySQL Server, Selecting Databases, Checking for Errors, Closing the MySQL Server

Connection, Inserting, Viewing, Updating and Deleting Records, Manipulating joined tables.		
Module:8	**Contemporary issues**	**2 hours**
Guest lecture by industry experts		
	Total Lecture hours:	**45 hours**
Text Book		
1.	Paul Deitel, Harvey Deitel, Abbey Deitel, Internet & World Wide Web - How to Program, 2020 6th edition, Pearson Education.	
Reference Books		
1.	Fritz Schneider, Thomas Powell, JavaScript – The Complete Reference, 2017, 3rd Edition, McGraw Hill.	
2.	Steven Holzener, PHP – The Complete Reference,2017, 1st Edition, Mc-Graw Hill	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab		
List of Experiments		
1.	Design static web pages required for an online book store web site using HTML and CSS	6 hours
2.	a. Write JavaScript program to validate the fields required for Book Store - registration page. b. Create and Validate the Login page c. After successful login, update the book details dynamically.	6 hours
3.	a. Write an XML file which will display the Book information which includes the following: Title of the book, Author Name, ISBN number, Publisher name, Edition, Price b. Write a Document Type Definition (DTD) to validate the above XML file.	4 hours
4.	a. Write PHP Program to Convert all the previous forms (Book Store Registration Page and Login Page) to PHP forms. b. Define Cart to select books and number of books, maintain Session for the page. c. Validate the Session data before completing the Order.	8 hours
5.	Write a PHP Code to make database connection and perform various CRUD operations	6 hours
	Total Laboratory Hours	**30 hours**
Mode of Assessment: Assessments/Midterm Exam/FAT		
Recommended by Board of Studies	**22-05-2021**	
Approved by Academic Council	**No. 62**	**Date** **15-07-2021**

Course Code	Course Title	L	T	P	J	C
CBS3015	Information Systems Audit and Control	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. Gain the knowledge about IS Auditing procedures
2. Understand the acquisition and development of IS controls
3.Implementation of Disaster Recovery Planning in an organization

Expected Course Outcome:

1. Identify the procedures involved in auditing process.
2.Understanding of policies, procedures and standards in Information System management
3.Describe the disaster recovery plan and Business Continuity Plan
4.Identify the maintenance and support activities in ISA
5. Understand the IS network Infrastructure and assets protection

Module:1	Process of Auditing IS	6 hours

Management of IS Audit Function – Risk Analysis – Internal Controls – Performing an IS Audit – Control Self-assessment – The Evolving IS Audit process

Module:2	Governance and Management of IT	7 hours

Corporate Governance – IS Strategy – IT Investment and allocation processes - Policies and Procedures – Risk Management – IS Management practices –IS Organizational structure and responsibilities – Business Continuity Planning – Auditing Business Continuity

Module:3	IS Operations, Maintenance and Support	7 hours

IS Operations- IS Hardware –IS Architecture and Software – IS Network Infrastructure – Auditing Infrastructure and Operations

Module:4	IS Acquisition, Development and DRP	7 hours

Auditing Application Controls – Auditing Systems Development Acquisition and Maintenance – Disaster Recovery Planning

Module:5	Protection of Information Assets	8 hours

Importance of Information Security Management - Logical Access – Network Infrastructure Security- Auditing Information Security Management Framework - Environmental Exposures and Control – Physical Access Exposures and Controls

Module:6	System Management	4 hours

IT processes - Systems Software - Label Checking - Library Protection – Memory Protection – Systems Maintenance- Open Systems – Database Technology - Auditing DBMS Recovery

Module 7	Application Control and Maintenance	4 hours

Application Risks- End User Computing Application Risks-Electronic data Interchange Application Risks-Application Controls-Application Software Lifecycle-Application controls-Corrective Maintenance – Adaptive Maintenance-Perfective Maintenance

Module 8	**Contemporary Issues**	**2 hours**
Guest lecture by Industry experts		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Sandra Senft, Frederick Gallegos, Aleksandra Davis, Information Technology Control and Audit, 2013, 4th edition, Auerbach Publications.
2.	Angel R. Otero, Information Technology Control and Audit, 2019, 5th edition, CRC Press.
Reference Books	
1.	Jack J. Champlain, Auditing Information Systems, 2003, 2nd edition, Wiley publishers.
2.	Ron Weber, Information System Control and Audit, 2014, 4th edition, Pearson Publication

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course Code	Course Title	L	T	P	J	C
CBS3016	Cognitive Science & Analytics	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To understand the way in which cognitive science is methodologically distinctive while at the same time is an interdisciplinary field where established fields of research—including Psychology, Computer Science, Linguistics, Neuroscience.
2. To develop skills in analyzing, interpreting, and assessing the empirical data and research techniques that contribute to cognitive science.
3. To understand central modeling techniques in cognitive science, including traditional computational approaches, neural network/deep learning approaches, and dynamical approaches.

Expected Course Outcome:

1. To understand the basic principles and process of cognitive science
2. Learn and understand the learning model and apply the same to appropriate real world applications
3. To demonstrate qualitative and quantitative skill and critical thinking on cognitive science by applying suitable methodology to real world applications
4. Students will understand and apply declarative and logic models
5. Envisage the concept of cognitive learning
6. To demonstrate the acquired inter-disciplinary knowledge in language processing and application of different research approaches with cognitive science

Module:1	Introduction to Cognitive Science	7 hours

Introduction to the study of cognitive sciences. Neural Network Models- language: definition Affordances Categories and concepts; Concept learning: Linguistic knowledge: Syntax, semantics, (and pragmatics) Direct perception, Logic; Machine learning.

Module:2	Concept Hierarchies	7 hours

A brief history of cognitive science. Processing of sensory information in the brain, Linguistic knowledge: Syntax, semantics, (and pragmatics), Ecological Psychology, Constructing memories Methodological concerns in philosophy, Discretization and generating concept hierarchies, Data Mining System, Generative linguistic, Affordance learning in robotics, Explicit vs. implicit memory

Module:3	Anatomy of brain	7 hours

Artificial intelligence and psychology, Brain Imaging, Brain and language, Affordance learning in robotics, Information processing (three-boxes) model of memory Structure and constituents of the brain fMRI, MEG, Language disorders, Development Information processing (three-boxes) model of memory.

Module:4	Memory Models	6 hours

Brief history of neuroscience, PET, EEG Lateralization Child and robotic development Sensory memory; Short term memory Mathematical models, Multisensory integration in cortex, Lateralization, Attention and related concepts, long term memory; Rationality

Module:5	**Sensory Information fusion**	**5 hours**
Mathematical models Information fusion, the great past tense debate, Human visual attention, Bounded rationality; Prospect theory; Heuristics and biases Looking at brain signals.		
Module:6	**Modelling**	**6 hours**
From sensation to cognition, The great past tense debate, Computational models of attention, Reasoning in computers, Cybernetics, Cognitivist and emergent stand points, Computational models of attention, Key points in social cognition,		
Module:7	**Information processing**	**5 hours**
Processing of sensory information in the brain. From physics to meaning, Analog vs. Digital: Code duality. A robotic perspective, Applications of computational models of attentional Context and social judgment; Schemas; Social signals		
Module:8	**Contemporary issues**	**2 hours**
Recent trends by Industry experts		
	Lecture hours	**45 hours**

Text Book

1.	Pradeep KumarMallick, Samarjeet Borah," Emerging Trends and Applications in Cognitive Computing", 2019, IGI Global Publishers.

Reference Books

1.	Jose Luis Bermudez, "Cognitive Science: An Introduction to the Science of the Mind", 2020 Cambridge University Press, New York.

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

List of Experiments

1.	Overview and practice: Cognitive Science and its methodology concerns in philosophy.	2 hours
2.	Experimental approach to studying the working human brain and body. How to use Brain Voyager Brain Tutor. How to use the BESA dipole simulator.	2 hours
3.	Experimental approach to processing sensory information in the brain using python.	2 hours
4.	Overview and practice: Written materials needed to get a CogNeuro research study with human subjects off the ground: Runsheets, SOPs, questionnaires, informed consent forms.	2 hours
5.	Introduction to EEG recordings. Theory, physiology, practicalaspects of recording and analysing scalprecorded brain potentials.	2 hours
6.	EEG analysis: How to get from the raw recording to specific brain waves. An example analysis.	2 hours
7.	Perform stemming operation in python using NLTK	2 hours
8.	Perform lemmatization in python using NLTK	2 hours
9.	Perform parts of speech tagging in python using NLTK	2 hours
10.	Writing and running Robot programs – Activity of PICK and Place of an object.	2 hours
11.	Make simulation model using Rockwell ARENA 11.0 to show the functions / predictions for a manufacturing work cell.	2 hours

12.	Simulation modelling of four machine system using Rockwell ARENA 11.0.	2 hours
13.	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.	2 hours
14.	Evaluating ML algorithm with balanced and unbalanced datasets Comparison of Machine Learning algorithms.	2 hours
15.	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data, set for clustering using k- Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.	2 hours
	Total Laboratory Hours	**30 hours**

Mode of Assessment: Assessment/Midterm Exam/FAT			
Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course Code	Course title	L	T	P	J	C
CBS4001	Robotics and Embedded Systems	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To introduce the concepts of embedded system design, peripherals and its modeling
2. To teach the importance of RTOS and illustrate various real world examples
3. To introduce basics of robot, mathematics and its applications

Expected Course Outcome:

1. To acquire knowledge about embedded system design and basics of robot.
2. Ability to understand the internal architecture and interfacing of different peripheral devices with microcontrollers.
3. Ability to understand the modelling of hardware software requirements and their trade-offs.
4. To learn RTOS and its issues for real time system design
5. To illustrate various real world case studies
6. Ability to design a component or a product applying all the relevant standards and with realistic constraints

Module:1	Introduction to Embedded System	5 hours

Embedded system Vs General computing systems, History of Embedded systems, Purpose of Embedded systems, Microprocessor and Microcontroller, Hardware architecture of the real time systems.

Module:2	Devices and Communication Buses	6 hours

I/O types, serial and parallel communication devices, wireless communication devices, timer and counting devices, watchdog timer, real time clock, serial bus communication protocols, parallel communication network using ISA, PCI, PCT-X, and Internet embedded system network protocols, USB, Bluetooth.

Module:3	Program Modelling	6 hours

Concepts, Fundamental issues in Hardware software co-design, Unified Modelling Language (UML), Hardware Software trade-offs - DFG model, state machine programming model, model for multiprocessor system.

Module:4	Real Time Operating Systems	7 hours

Operating system basics, Tasks, Process and Threads, Multiprocessing and multitasking, task communication, task synchronization, qualities of good RTOS.

Module:5	Examples of Embedded System	7 hours

Mobile phones, RFID, WISENET, Robotics, Biomedical Applications, Brain machine interface etc. Popular microcontrollers used in embedded systems, sensors, actuators.

Module:6	Introduction to Robots	5 hours

Robotics: Introduction, Elements of robots -- joints, links, actuators, and sensors

Module:7	**Kinematics and Algorithms**	**7 hours**
Kinematics of serial robots, Kinematics of parallel robots, Motion planning and control, Sensing distance and direction, Line Following Algorithms, Feedback Systems, Other topics on advance robotic techniques		
Module:8	**Contemporary issues**	**2 hours**
Recent trends and open challenges		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Shibu K. V , "Introduction to Embedded Systems", 2nd Edition, McGraw Hill, 2017
2.	Ashitava Ghosal, "Robotics: Fundamental Concepts and Analysis", Oxford University Press, 2006.
Reference Books	
1.	L. B. Das, "Embedded Systems: An Integrated Approach",1st edition, Pearson Education India, 2012.
2.	Raj Kamal, "Embedded Systems- Architecture, Programming and Design", 3rd Edition, McGraw Hill Education, 2017.

Mode of Evaluation: CAT / Digital Assignment / Quiz / FAT / Lab

Lab Experiments

1.	Arithmetic Operations using 8051	2 hours
2.	Interfacing ADC and DAC	4 hours
3.	Interfacing LED and PWM	2 hours
4.	Interfacing real time clock and serial port	2 hours
5.	Interfacing keyboard and LCD	4 hours
6.	Flashing LEDS	2 hours
7.	Interfacing stepper motor and temperature sensor	4 hours
8.	Study of robotic arm and its configurations	6 hours
9.	Study of robotic end effectors	4 hours
	Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS4002	Cryptology and Analysis	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v.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 of cryptanalysis and quantum cryptography

Expected 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 the requirements for secure communication and challenges related to the secure applications
5. Ability to identify the need of quantum cryptographic solutions.

Module:1	**Introduction to Cryptography**	**6 hours**

Introduction to Cryptography: Elementary number theory, Pseudo-random bit generation, Elementary cryptosystems.

Basic security services: confidentiality, integrity, availability, non-repudiation, privacy

Module:2	**Basic Symmetric Key Cryptosystems**	**8 hours**

Stream Cipher: Basic Ideas, Hardware and Software Implementations, Examples with some prominent ciphers: A5/1, Grain family, RC4, Salsa and ChaCha, HC128, SNOW family, ZUC

Module:3	**Advanced Symmetric Key Cryptosystems**	**5 hours**

Block Ciphers: DES, AES, Modes of Operation; Hash Functions; Authentication

Module:4	**Public Key Cryptosystems**	**5 hours**

RSA, ECC; Digital signatures

Module:5	**Basic Security Applications**	**6 hours**

Electronic commerce (anonymous cash, micro-payments), Key management, Zero-knowledge protocols

Module:6	**Advanced Security Applications**	**5 hours**

Cryptology in Contact Tracing Applications, Issues related to Quantum Cryptanalysis Electronic

Module:7	**Post-Quantum Cryptography**	**8 hours**

Post-Quantum Cryptography, Public-Key Post-Quantum Cryptographic Algorithms, Stateful Hash-Based Signatures, Threshold Cryptography

Module:8	**Contemporary issues**	**2 hour**

Recent Trends in Cryptanalysis

Total Lecture hours:	**45 hours**

Text Book(s)	
1.	W. Stallings, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson, 2017.
2.	A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, Handbook of Applied Cryptography., CRC Press, 2011
Reference Books	
1.	C. S. Mukherjee, D. Roy, S. Maitra, Design & Cryptanalysis of ZUC - A Stream Cipher in Mobile Telephony. Springer, 2020
2.	D. R. Stinson, Cryptography, Theory and Practice. CRC Press, 2014.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS4003	Quantum Computation & Quantum Information	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To understand the fundamental concepts on quantum computing
2. To learn how to do computation using quantum algorithms
3. To process secure information in various modern-day applications

Expected Course Outcome:

1. Understand the basic concepts on quantum computing
2. Able to implement quantum algorithms for performing computations on quantum computers
3. Generate perfectly unpredictable random numbers to ensure the strongest level of encryption
4. Ensure secure communication using quantum key distribution method
5. Evaluate and standardize quantum-resistant public-key cryptographic algorithms
6. Perform quantum computations to solve simple problems

Module:1	**Introduction to Quantum Information**	**6 hours**
States, Operators, Measurements, Quantum Entanglement: Quantum Teleportation, Super-dense coding, CHSH Game, Quantum gates and circuits.		
Module:2	**Quantum Algorithms Basic**	**8 hours**
Deutsch-Jozsa, Simon, Grover, Shor, Implication of Grover's and Simon's algorithms towards classical symmetric key cryptosystems		
Module:3	**Quantum Algorithms Advanced**	**8 hours**
Implication of Shor's algorithm towards factorization and Discrete Logarithm based classical public key cryptosystems		
Module:4	**Quantum True Random Number Generators (QTRNG):**	**7 hours**
Quantum True Random Number Generators (QTRNG): Detailed design and issues of quantumness, Commercial products and applications		
Module:5	**Basic Quantum key distribution**	**4 hours**
Quantum key distribution (QKD): BB84, Ekert, Semi-Quantum QKD protocols		
Module:6	**Advanced Quantum key distribution**	**4 hours**
Variations in Semi-Quantum QKD protocols, Issues of Device Independence, Commercial products		
Module:7	**Introductory topics in Post-Quantum Cryptography**	**6 hours**
Refer to https://csrc.nist.gov/projects/post-quantum-cryptography. May discuss any two ciphers from this list.		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)		
1.	M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press. 2010.	
2.	Chris Bernhardt, Quantum Computing for Everyone, MIT Press 2019.	
Reference Books		
1.	Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/	
2.	NIST Post Quantum Cryptography, Available online: https://csrc.nist.gov/projects/post-quantum-cryptography/	
Lab Experiments		
1.	Introduction of quantum Instruction Set Architecture for quantum computations	3 hours
2.	Use of quantum instruction language such as Quil, etc. for performing any quantum computations	3 hours
3.	Programs using bits and qubits	3 hours
4.	Implementation of quantum algorithms - Deutsch–Jozsa problem, Simon's algorithm and Shor's algorithm	6 hours
5.	Implement classical logics using quantum circuits	3 hours
6.	Program to implement Quantum counting	3 hours
7.	Program for Quantum optimization algorithms	3 hours
8.	Program for quantum walk to solve problems include search and sampling without errors	3 hours
9.	Implementation of Quantum algorithm for solving linear systems of equations	3 hours
	Total	**30 hours**

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS4004	Image Processing and Pattern Recognition	3	0	0	4	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To deliver the fundamental concepts of image processing and pattern recognition
2. To understand various image processing steps and their applications in real time.
3. To assist the students to incorporate pattern recognition in image processing and its importance in real time applications.

Expected Course Outcome:

1. Describe the basic concepts of image processing with mathematical interpretation
2. Apply the knowledge of different image enhancement, and image registration techniques.
3. Demonstrate the various image segmentation and morphological operations for partition of objects
4. Acquire the concepts of color image processing.
5. Describe the fundamental concepts of various feature extraction techniques and recognize the image scene from image feature.
6. Analyze and implement image processing techniques for various real-time applications such as industry, medicine and defense.

Module:1	Digital Image Fundamentals	8 hours

Introduction: Image processing systems and its applications. Basic image file formats
Image formation: Geometric and photometric models; Digitization - sampling, quantization; Image definition and its representation, neighbourhood metrics.

Module:2	Image Enhancement	6 hours

Enhancement, contrast stretching, histogram specification, local contrast enhancement; Smoothing, linear and order statistic filtering, sharpening, spatial convolution, Gaussian smoothing, DoG, LoG.

Module:3	Image registration	6 hours

Registration: Mono-modal/multimodal image registration; Global/local registration; Transform and similarity measures for registration; Intensity/pixel interpolation.

Module:4	Morphological processing	5 hours

Morphological Filtering Basics: Dilation and Erosion Operators, Opening and Closing operators, Region filling, Objects Skeletons-Thinning and Thickening boundaries, Convex Hull, Top Hat Filters

Module:5	Image Segmentation	7 hours

Segmentation: Pixel classification; Grey level thresholding, global/local thresholding; Optimum thresholding - Bayes analysis, Otsu method; Derivative based edge detection operators, edge detection/linking, Canny edge detector; Region growing, split/merge techniques.

Module:6	Color Image Processing	5 hours

Fundamentals of different colour models - RGB, CMY, HSI, YCbCr, Lab; False colour; Pseudo colour; Enhancement; Segmentation.

Module:7	**Image/Object features extraction**	**6 hours**
Textural features - gray level co-occurrence matrix; Moments; Connected component analysis; Convex hull; Distance transform, medial axis transform, skeletonization/thinning, shape properties		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson, 2018.
2.	William K. Pratt, Digital Image Processing, 4th Edition, John Wiley, 2007.

Reference Books

1.	Maria Petrou and Panagiota Bosdogianni, "Image Processing: The Fundamentals", 2nd edition, John Wiley, 2010
2.	Kenneth R. Castleman, "Digital Image Processing", 2nd Edition, Pearson, 2010

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

Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS4005	Enterprise systems	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To introduce the essential concepts of ERP involved in business processes
2. To impart skills in the design and implementation of ERP architecture
3. To familiarize with various tools and technologies for developing ERP for large project

Expected Course Outcome:

1. Ability to design and deploy simple web applications using MVC architecture
2. Evaluate SOA and ERP models
3. Ability to design and implement CRM models
4. Implement interactive network and application
5. Evaluate organizational opportunities and challenges in the design system
6. Ability to develop model for ERP for large projects

Module:1	Model - View - Control (MVC)architecture	6 hours

Overview of MVC -MVC method of software development in a 3-tier environment -Control (MVC) development in a 3-tier environment.

Module:2	Tools and Technologies	6 hours

Tools and Technologies: - Microsoft .NET framework, PHP, Ruby on Rails, JavaScript, Ajax and Overview of SAP and Oracle Applications

Module:3	ERP Architecture and Generic Modules	8 hours

Service Oriented Architecture (SOA) - Principles of loose coupling – encapsulation - Inter-operability - Enterprise Resource Planning (ERP) systems and their architecture - Generic ERP Modules: Finance, HR, Materials Management, Investment - Examples of Domain Specific Modules

Module:4	ERP Technologies	7 hours

Business Process Reengineering - Decision Support System - On-Line Analytical Processing -Electronic Data Exchange - Customer Relationship Management (CRM) - Supplier Relationship Management (SRM)

Module:5	ERP Networking & Security	6 hours

Overview of MPLS - Virtual Private Networks (VPN) – Firewalls - Network monitoring and enforcement of policies - ERP Security Issues – Authentication – Authorisation - Access control – Roles - single-sign-on -Directory servers - Audit trails - Digital signatures – Encryption - review of IPSec - SSL

Module:6	Software Architectures for Enterprise Systems	5 hours

Software: Acquisition Process – Tendering - conditions of contract - Commercial off the shelf software (COTS) Implementations - Bespoke Implementations - Total cost of ownership - Issues on using Open source software or free software and Licensed software

Module:7	**Hardware Architectures for Enterprise Systems**	**5 hours**
Hardware: Servers –Storage area networks - Storage units - Back-up strategies - Local Area Network (LAN) technologies and products - Data Centres - Hardware Acquisition - Disaster Recovery		
Module:8	**Contemporary issues**	**2 hours**
Industry experts lecture		
	Total Lecture Hours:	**45 hours**

Textbook	
1.	Alexis Leon, Enterprise Resource Planning, 2020,4th Edition, Tata McGraw Hill.
Reference Books	
1.	Kurbel, K. E., Enterprise Resource Planning and Supply Chain Management, 2016, Springer.
2.	Ganesh K, Sanjay M, Anbuudayasankar S.P, Sivakumar P., Enterprise Resource Planning - Fundamentals of Design and Implementation, 2014, Springer.

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

List of Challenging Experiments (Indicative)		
1.	Creating an ASP.NET MVC web application project	2 hours
2.	Explore the client/server architecture of SAP. Learn how to use the user interface	2 hours
3.	Create customer, material master data. Execute the sales process in SAP	3 hours
4.	Create a model of customer relationship management and business intelligence systems for catalogue and online retailers	3 hours
5.	Create a model of Supplier Relationship Management for Healthcare system	3 hours
6.	Configure and test a VPN connection on a personal computer	4 hours
7.	Firewalls configuration	4 hours
8.	COTS configuration and implementation	3 hours
9.	Use CASE tools to aid ERP Software acquisition process - Case study	3 hours
10.	Use CASE tools to aid ERP hardware acquisition process - Case study	3 hours
	Total Laboratory Hours:	**30 hours**

Mode of Assessments: Assessments/Midterm Exam/FAT			
Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course code	Course Title	L	T	P	J	C
HUM1046	Behavioral Economics	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To impart knowledge on current ideas and concepts regarding decision making in Economics, Particularly from a behavioral science perspective.
2. The course will explore key departures and the consequences of behavior of firms, households and other economics entities
3. To provide an overview of how behavioral principles have been applied to economic problems.

Expected Course Outcome:

1. Identify and evaluate evidence for systematic departures of economic behavior from the Predictions of the neoclassical model, and psychological explanations for these anomalies.
2. Incorporate psychologically motivated assumptions into economic models, and interpret the implications of these assumptions.
3. Explain how these models change the predictions for equilibrium behavior and welfare analysis, and assess the implications for optimal policy.
4. Compare the predictions of neoclassical and behavioral models, and evaluate the best method for approaching a given topic.
5. Apply Behavioral principles in economic problems.

Module:1	Introduction	6 hours

The neoclassical/standard model and behavioral economics in contrast; historical background; behavioral economics and other social sciences; theory and evidence in the social sciences and in behavioral economics; applications – gains and losses, money illusion, charitable donation.

Module:2	Basics of Choice Theory	6 hours

Revisiting the neoclassical model; utility in economics and psychology; models of rationality; connections with evolutionary biology and cognitive neuroscience; policy analysis – consumption and addiction, environmental protection, retail therapy; applications – pricing, valuation, public goods, choice anomalies.

Module:3	Beliefs, Heuristics and Biases	6 hours

Revisiting rationality; causal aspects of irrationality; different kinds of biases and beliefs; self-evaluation and self-projection; inconsistent and biased beliefs; probability estimation; trading applications – trade in counterfeit goods, financial trading behavior, trade in memorabilia.

Module:4	Choice under Uncertainty	6 hours

Background and expected utility theory; prospect theory and other theories; reference points; loss aversion; marginal utility; decision and probability weighting; applications – ownership and trade, income and consumption, performance in sports.

Module:5	Intertemporal Choice	6 hours

Geometric discounting; preferences over time; anomalies of inter-temporal decisions; hyperbolic

discounting; instantaneous utility; alternative concepts – future projection, mental accounts, heterogeneous selves, procedural choice; policy analysis – mobile calls, credit cards, organization of government; applications – consumption and savings, clubs and membership, consumption planning.		
Module:6	**Game and Strategy Behavior**	**6 hours**
Review of game theory and Nash equilibrium – strategies, information, equilibrium in pure and mixed strategies, iterated games, bargaining, signaling, learning; applications – competitive sports, bargaining and negotiation, monopoly and market entry.		
Module:7	**Social Preference**	**7 hours**
Individual preferences; choice anomalies and inconsistencies; social preferences; altruism; fairness; reciprocity; trust; learning; communication; intention; demographic and cultural aspects; social norms; compliance and punishment; inequity aversion; policy analysis – norms and markets, labor markets, market clearing, public goods; applications – logic and knowledge, voluntary contribution, compensation design.		
Module:8	**Contemporary Issues**	**2 hours**
Guest lectures by Industrial Experts.		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	N. Wilkinson and M. Klaes, "An Introduction to Behavioral Economics", 2017, 3rd Edition, Red Globe Press.
Reference Books	
1.	Bazerman, Max and Don Moore. Judgment in Managerial Decision Making, 2012. 8th Edition, John Wiley & Sons.
2.	Kahneman, Daniel.Thinking, Fast and Slow, 2011, New York: Farrar, Straus and Giroux.

Mode of Evaluation: CAT / written assignment / Quiz / FAT			
Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course code	Course title	L	T	P	J	C
HUM1047	Engineering Economics	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To enable students to identify and explain economic concepts and theories related to the behaviour of economic agents, markets, industry and firm structures.
2. To enable students to identify the determinants of various macroeconomic aggregates such as output, unemployment, inflation, productivity and the major challenges associated with the measurement of these aggregates.
3. To analyse cost/revenue data and carry out economic analyses to justify or reject alternatives/projects on an economic basis.

Expected Course Outcomes:

1. Understand the general principles of how the market economy functions
2. Analyse how consumers and producers make decisions and learn about different market structures.
3. To understand the general principles of consumption function and how an economy functions in a global environment.
4. Comprehend the ways in which the government and central bank can influence the economy and the markets through fiscal and monetary policies.
5. Evaluate the methods of cost estimation and to estimate present and future values of cash flows.
6. Evaluate projects using project appraisal techniques.

Module:1	Introduction to Microeconomics	6 hours

Demand and Supply- Consumers' Behavior – Indifference Curve Analysis- Applying the Demand and Supply Model- Taxes and Subsidies- Effects of changes in income and price.

Module:2	Theory of Production and Cost	6 hours

Production Function and Iso-quants-Cost Minimization; Cost Curves -Total, Average and Marginal Costs - Long Run and Short Run Costs.

Module:3	Market Structure	6 hours

Equilibrium of a Firm Under Perfect Competition; Monopoly and Monopolistic Competition.

Module:4	Introduction to Macroeconomics	6 hours

National Income and its Components- GNP, NNP, GDP, NDP; Consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector - Taxes and Subsidies; External Sector -Exports and Imports;

Module:5	IS-LM Model and Business Cycles	7 hours

Money - Definitions; Demand for Money -Supply of Money - Bank's Credit Creation Multiplier; IS LM Model; Business Cycles and Stabilization -Monetary and Fiscal Policy - Central Bank and the Government; The Classical Paradigm - Price and Wage Rigidities - Voluntary and Involuntary Unemployment.

Module:6	**Engineering Economics and Cost Estimation**	**6 hours**
Engineering Economics and Decision Making- Cost Concepts- Life Cycle Costing - Cost Estimation Techniques - Parametric and Non-Parametric techniques.		
Module:7	**Foreign Exchange Rates**	**6 hours**
Determination – effects- exchange rate regime: fixed, flexible, floating rates– methods of foreign payments – issues in Foreign exchange reserves. International Competitive Bidding- Issues.		
Module:8	**Contemporary issues**	**2 hours**
Guest lectures by Industrial Experts.		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Samuelson, Paul.A and William Nordhaus, "Economics", 2019, 20th Edition, McGraw Hill Publishers, New Delhi.
Reference Books	
1.	Sullivan G William, Elin M Wicks and C. Patrick Koelling, "Engineering Economy", 2018, 17th Edition, Pearson Education.
2.	Perloff, Jeffrey M, "Microeconomics", 2019, 7th Edition, Pearson Education.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course Code	Course Title	L	T	P	J	C
HUM1048	Industrial Psychology	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. Introduces students to the content areas of industrial psychology and the application of
2. Psychological theory to organizational issues. Acquiring knowledge topics include employment law, job analysis, recruitment and selection, training, performance appraisal and discipline, employee motivation, and workplace safety.
3. Using an applied approach, this course will help prepare students for their roles as employees and managers.

Expected Course Outcomes:

1. Become conversant about the major content areas of Industrial Psychology (i.e., job analysis, recruitment, selection, employment law, training, performance management, and health/well-being issues in the workplace).
2. Gain further comfort with statistical concepts in the context of making personnel decisions to reinforce content learned in PSY203 or an equivalent introductory statistics course.
3. Gain practical experience by completing a series of hands-on projects involving job analysis, selection decisions, training programs, and employee well-being.
4. Deepen your understanding of tests and measurements so that you can collect accurate information and make sound data-based decisions.
5. Prepare for other focused seminar courses in Industrial/Organizational Psychology or Human Resource Management.

Module:1	**Introduction**	**8 hours**

I/O Psychology-definition. Research Methods, Statistics, and Evidence-based Practice, Introduction & Legal Context of Industrial Psychology, Job Analysis & Competency Modelling, Job Evaluation & Compensation, Job Design & Employee Well-Being, Recruitment.

Module:2	**Evaluating the Quality of Performance Measures**	**7 hours**

Identifying Criteria & Validating Tests and Measures, Screening Methods, Intensive Methods.

Module:3	**Employees Performance and Evaluation**	**5 hours**

Performance Goals and Feedback, Performance Coaching and Evaluation, Evaluating Employee Performance.

Module:4	**Organisational Fairness and Diversity Management**	**6 hours**

Employee Motivation, Satisfaction and Commitment, Fairness and Diversity.

Module:5	**Leadership and Organisational Development**	**6 hours**

Leadership, Organizational Climate, Culture, and Development.

Module:6	**Organisational Behaviour**	**6 hours**

Teams in Organizations, The Organization of Work Behaviour		
Module:7	**Stress Management**	**5 hours**
Stress Management: Demands of Life and Work		
Module:8	**Contemporary issues**	**2 hours**
Guest Lecture by Industry experts		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Landy, F. J. and Conte, J. M. Work in the 21st Century,2013, 4th Edition. Oxford: Blackwell Publishing.
2.	Aamodt, M. Industrial/Organizational Psychology: An Applied Approach,2015, 8th Edition, Wadsworth Publishing Co.
Reference Books	
1.	Miner.B, J. Industrial-Organizational Psychology. 1992, McGraw Hill Inc., US.
2.	Ashwathappa, K. Human Resource Management: Text & Cases,2017,8th Edition, McGraw Hill Education.

Mode of Evaluation:CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

Course code	Course title	L	T	P	J	C
MGT3001	Business Strategy	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To introduce the concepts of strategic management and understand its nature in competitive and institutional landscape.
2. To develop a holistic approach to see business issues comprehensively and using other core and functional subject knowledge for decision-making.
3. To identify and interpret the critical challenges and opportunities before an organization.

Expected Course Outcome:

1. Learn the fundamental concepts of strategic management to analyze business situations and apply these concepts to solve business problems.
2. Understand the fundamental principles of and interrelationships among business functions such as: R&D, production, marketing, finance, HR and information technology
3. Understand the inter-relationships of business to individuals, other organizations, government and society.
4. Describe the tools of strategic analysis thoroughly, how they are used, and where they fit in the managerial process to frame and implement strategies.

Module:1	Introduction to Strategic Management	8 hours

Importance of Strategic Management, Vision and Objectives, Schools of thought in Strategic Management, Strategy Content, Process, and Practice, Fit Concept and Configuration Perspective in Strategic Management

Module:2	Internal Environment of Firm- Recognizing a Firm's Intellectual Assets	7 hours

Core Competence as the Root of Competitive Advantage, Sources of Sustained Competitive Advantage, Business Processes and Capabilities-based Approach to Strategy

Module:3	External Environments of Firm- Competitive Strategy	6 hours

Five Forces of Industry Attractiveness that Shape Strategy, The concept of Strategic Groups, and Industry Life Cycle

Module:4	Generic strategies	5 hours

Generic Strategies, Generic Strategies and the Value Chain

Module:5	Corporate Strategy, and Growth Strategies	6 hours

The Motive for Diversification, Related and Unrelated Diversification, Business Portfolio Analysis

Module:6	Contesting with competitors in overseas markets	6 hours

Expansion, Integration and Diversification, Strategic Alliances, Joint Ventures, and Mergers & Acquisitions

Module:7	Strategy Implementation: Structure and Systems	5 hours

The 7S Framework, Strategic Control and Corporate Governance		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Strategic management of technological innovation (2019), Schilling, M. A., & Shankar, R,McGraw-Hill Education.
2.	The business of platforms: Strategy in the age of digital competition, innovation, and power (2019), Cusumano, M. A., Gawer, A., & Yoffie, D. B.,New York: Harper Business.
Reference Books	
1.	Dislodging multinationals: India's strategy in comparative perspective (2019), Encarnation, D.Cornell, University Press.
2.	Dynamics of knowledge intensive entrepreneurship: Business strategy and public policy (2018), Malerba, F., Caloghirou, Y., McKelvey, M., & Radoševic, S. (Eds.), Routledge.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
MGT3002	Advanced Finance	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. Imbibe knowledge about the decisions and decision variables involved with financial activities of the firm.
2. Develop skills for interpretation business information and application of financial theory in corporate investment decisions, with special emphasis on working capital management.
3. Familiarizing the students with the corporate and financial restructuring.

Expected Course Outcome:

1. Informing the students about the various financial instruments and make them understand about the Corporate Dividend decisions, is the main objective.
2. The Leasing and decisions involving Leasing shall make the students achieve the Organizational goals, with optimum investment.
3. Familiarizing the students with the corporate and financial restructuring.
4. Develop skills for interpretation of business information and application of financial theory in corporate investment decisions, with special emphasis on working capital management.
5. Giving the basic knowledge about the Derivatives.

Module:1	Introduction	4 hours

Sources of Funds (including regulatory framework)-Types of securities-Issuing the capital in market-Pricing of issue-Valuation of Stocks and bonds

Module:2	Dividend Decisions:	6 hours

Traditional Approach, Dividend Relevance Model, Miller and Modigliani Model, Stability of Dividends, Forms of Dividends, Issue of bonus shares, Stock Split

Module:3	Leasing Contracts	6 hours

Evaluation of Lease Contracts

Module:4	Corporate Restructuring	6 hours

Mergers and Acquisitions- Types of Mergers, Evaluation of Merger Proposal-Take-over-Amalgamation-Leverage buy-out-Management buy-out-Corporate Failure and Liquidation

Module:5	Financial Restructuring	4 hours

Share Split-Consolidation-Cancellation of Paid-up Capital-Other Mechanisms

Module:6	Working Capital Management:	11 hours

Working Capital Planning-Monitoring and Control of Working Capital-Working Capital Financing-Managing the Components of Working Capital-Cash Management-Receivable Management-Inventory Management

Module 7	**Introduction to derivatives**	**6 hours**
Basics of Futures, Forwards, Options, Swaps-Interest rate Payoff Diagrams, Pricing of Futures, Put Call Parity, Option Pricing using Binomial Model and Black Scholes Model-Use of Derivatives for Risk-Return Management- Credit Default Swaps		
Module 8	**Recent Trends**	**2 hours**
Contemporary Issues in Finance		
	Total Lecture Hours	**45 Hours**

Text Books:

1.	Brealey, Myers and Allen, Principles of Corporate Finance, McGraw Hill Education (2018)
2.	I.M. Pandey, Corporate Finance, Vikas Publishing House (2015)

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
MGT4004	Human Resource Management	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. Familiarize the basic concepts functional areas and activities of Human Resource Management
2. Understand and apply HRM concepts in organisational context
3. Understand how HRM activities lead to performance and sustainability of the organisation.

Expected Course Outcome:

1. Understand the basic concepts of HRM
2. Understand the HR functions and activities in organisations
3. Align HRM activities with real time organisational environment.
4. Comprehend cross-cultural work dynamics and HR activities.
5. Understand the impact of HR activities on different career outcomes

Module:1	Human Resource Management	8 hours

Human Resource Management: Concept and Challenges, HR Philosophy, Policies, Procedures and Practices.

Module:2	Human Resource System Design	6 hours

HR Profession, and HR Department, Line Management Responsibility in HRM, Measuring HR, Human resources accounting and audit; Human resource information system

Module:3	Functional Areas of HRM	6 hours

Recruitment and staffing, benefits, compensation, employee relations, HR compliance, organizational design, training and development, human resource information systems (H.R.I.S.) and payroll.

Module:4	Human Resource Planning	6 hours

Demand Forecasting, Action Plans– Retention, Training, Redeployment & Staffing, Succession Planning

Module:5	Strategic Management of Human Resources	6 hours

SHRM, relationship between HR strategy and overall corporate strategy, HR as a Factor of Competitive Advantage

Module:6	Managing Diverse and inclusive workforce	6 hours

Demographic and Cultural Diversity, Global Context for Diversity Management, Social Psychological Perspectives of Workforce Diversity

Module:7	Human Resource Management in Service Sector	5 hours

Managing the Customer – Employee Interaction, Employee Empowerment and Customer Satisfaction, Service Failure and Customer Recovery – the Role of Communication and Training, Similarities and Differences in Nature of Work for the Frontline Workers and the Backend, Support Services - Impact on

HR Practices Stressing Mainly on Performance, Flexible Working Practices – Implications for HR		
Module:8	**Contemporary issues**	**2 hours**
Expert lecture on Recent trends		
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Dessler G, Varrkey B. Human Resource Management, 2020, 16th edition. Pearson Education India	
Reference Books		
1.	Joseph J. Martocchio, Human Resource Management, 2019, 15th edition, Pearson Education Champaign.	
2.	Mathis RL, Jackson JH. Human resource management, 2021,15th edition, Jakarta: SalembaEmpat.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab		
Recommended by Board of Studies	**22-05-2021**	
Approved by Academic Council	**No. 62**	**Date** **15-07-2021**

Course Code	Course Title	L	T	P	J	C
MGT4005	Computational Finance & Modeling	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To study financial data analysis and modelling
2. To acquire quantitative finance skills, application of tools and techniques
3. To advance knowledge in designing, developing and testing of computational finance models

Expected Course Outcome:

1. Ability to analyse financial data
2. Understand the mathematical foundations of finance
3. Knowledge of financial markets and instruments
4. Understand option pricing models and its applications
5. Measuring and managing various types of financial risks
6. Design and test computational finance models

Module:1	Financial Markets and Instruments	7 hours

Financial Products and Markets: Introduction to the financial markets and the products which are traded in them: Equities, indices, foreign exchange, and commodities. Options contracts and strategies for speculation and hedging-an introduction.

Statistical Analysis of Financial Returns: Fat-tailed and skewed distributions, outliers, stylized facts.

Module:2	Mathematical Finance	7 hours

Numerical methods relevant to integration, differentiation and solving the partial differential equations of mathematical finance: examples of exact solutions including Black Scholes and its relatives, finite difference methods including algorithms and question of stability and convergence, treatment of near and far boundary conditions, the connection with binomial models, interest rate models, early exercise, and the corresponding free boundary problems, and a brief introduction to numerical methods for solving multi-factor models

Module:3	Financial derivatives	7 hours

Black-Scholes framework: Black-Scholes PDE: simple European calls and puts; put-call parity. The PDE for pricing commodity and currency options. Discontinuous payoffs - Binary and Digital options. The Greeks: theta, delta, gamma, vega& rho and their role in hedging. The mathematics of early exercise - American options: perpetual calls and puts; optimal exercise strategy and the smooth pasting condition. Volatility considerations - actual, historical, and implied volatility.

Module:4	Data simulation and analysis	7 hours

Simulation including random variable generation, variance reduction methods and statistical analysis of simulation output. Pseudo random numbers, Linear congruential generator, Mersenne twister RNG. The use of Monte Carlo simulation in solving applied problems on derivative pricing discussed in the current finance literature.

The technical topics addressed include importance sampling, Monte Carlo integration, Simulation of Random walk and approximations to diffusion processes, martingale control variables stratification, and the estimation of the "Greeks".

Module:5	Volatility Estimation	6 hours

Volatility, implied volatility surface, and volatility estimation using high frequency data. Volatility estimation

models- ARCH-GARCH-other advanced models. CBOE VIX and India VIX indices. Volatility smile.		
Module:6	**Options and applications**	**4 hours**
Application areas include the pricing of American options, pricing interest rate dependent claims, and credit risk. The use of importance sampling for Monte Carlo simulation of VaR for portfolios of options.		
Module:7	**Options and alternative models**	**5 hours**
Copulas, Hedging in incomplete markets, American Options, Exotic options, Electronic trading, Jump Diffusion Processes, High-dimensional covariance matrices, Extreme value theory, Statistical Arbitrage.		
Module:8	Contemporary Issues	**2 hours**
Industry expert Lecture on recent trends		
	Total Lecture Hours	**45 hours**

Text Book(s)	
1.	Paul Wilmott, Paul Wilmott on Quantitative Finance, 3 Volume Set, 2013, 2nd edition, wiley
2.	JoergKienitz and Daniel Wetterau, Financial Modelling: Theory, Implementation and Practice with MATLAB, 2012, 1st edition, Wiley Finance Series.
Reference Books	
1.	Dan Stefanica., A Primer for the Mathematics Of Financial Engineering, 2011, 2nd Edition FE Press, New York.
2.	John C. Hull and Sankarshan Basu, Options, futures & other derivatives, 2018, 10th edition, Pearson India.
3.	Tsay, Ruey S. Analysis of Financial Time Series, 2011, 3rd edition, John Wiley & Sons.
4.	R. Seydel: Tools for Computational Finance, 2017, 6th edition, Springer.
5.	David Ruppert, Statistics and Data Analysis for Financial Engineering, 2011, Springer.

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

List of Experiments

The following lab experiments could be planned on MATLAB-Computational Finance suite.

1.	Working with financial market data: data import, charting and basic analysis	2 hours
2.	Financial data: statistical analysis and simulation	2 hours
3.	Time series analysis	4 hours
4.	Volatility estimation	4 hours
5.	Option pricing models and analysis	3 hours
6.	Interest rate modelling and sensitivity analysis	3 hours
7.	Portfolio analysis and optimization	3 hours
8.	Risk estimation and hedging	3 hours
9.	Value at Risk (VaR) models	3 hours
10.	High frequency data analysis	3 hours
	Total Laboratory hours	**30 hours**

Mode of Assessments: Assessments/Midterm exam/FAT

Recommended by Board of Studies	**22-05-2021**		
Approved by Academic Council	**No. 62**	**Date**	**15-07-2021**

UNIVERSITY CORE

(2020 - 2021)

B. Tech. Computer Science and Engineering and Business Systems

(in collaboration with TCS)

Course Code	Course Title	L	T	P	J	C
CBS1002	Object Oriented Programming	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To provide basic characteristics of OOP through C++.
2. To impart skills on various kinds of overloading and inheritance.
3. To introduce pointers and file handling in C++ together with exception handling mechanism.

Expected Course Outcome:

After completion of this course, students will be able to:

1. Realize the need and features of OOP and idealize how C++ differs from C.
2. Infer knowledge on various types of overloading.
3. Choose suitable inheritance while proposing solution for the given problem.
4. Handle pointers and effective memory management.
5. Illustrate application of pointers in virtual functions.
6. Demonstrate file handling in C++ and handle exceptions.
7. Showcase the attained knowledge by applying the learned techniques to solve various real-world problems.

Module:1	Introduction	3 hours

What is object-oriented programming? Why do we need object oriented? Programming characteristics of object-oriented languages.

Module:2	C++ Programming Basics	4 hours

Output using cout. Directives, Input with cin, Type bool, The setw manipulator, Type conversions.

Module:3	Operator overloading:	7 hours

Overloading unary operations. Overloading binary operators, data conversion, pitfalls of operator overloading and conversion keywords. Explicit and Mutable.

Module:4	Inheritance	8 hours

Concept of inheritance. Derived class and based class. Derived class constructors, member function, inheritance in the English distance class, class hierarchies, inheritance and graphics shapes, public and private inheritance, aggregation: Classes within classes, inheritance and program development.

Module:5	Pointers & Virtual Function	7 hours

Addresses and pointers. The address of operator and pointer and arrays. Pointer and Faction pointer and C-types string. Memory management: New and Delete, pointers to objects, debugging pointers. Virtual Function, friend function, Static function, Assignment and copy initialization, this pointer, dynamic type information.

Module:6	**Streams And Files**	**8 hours**
Streams classes, Stream Errors, Disk File I/O with streams, file pointers, error handling in file I/O with member function, overloading the extraction and insertion operators, memory as a stream object, command line arguments, and printer output.		
Module:7	**Generic Programming and Exceptions**	**6 hours**
Function templates, Class templates, Exception handling techniques.		
Module:8	**Case Studies on Complex problem Solving**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Debasish Jana, "C++ and Object-Oriented Programming Paradigm" Third Edition, PHIPublishers, 2014.
2. R Rajaram, "Object Oriented Programming and C++", Revised Edition, New Age International, 2007.

Reference Books

1. Shah Yi, Mh Thaker, "Programming In C++", First Edition, USA ISTE, 2002.
2. Stanley B. Lippman, Josée Lajoie and Barbara E. Moo, "C++ Primer", Fifth Edition,O'Reilly, 2013.

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

List of Challenging Experiments (Indicative)		
1.	Fundamental constructs in C++ including Classes and Objects	3 hours
2.	Constructors and Destructors	3 hours
3.	Types of Overloading	3 hours
4.	Types of inheritance	3 hours
5.	Pointers and Inheritance	3 hours
6.	Virtual Functions	3 hours
7.	File streams	3 hours
	Total Laboratory hours	**21 hours**

Mode of Assessments: Assessments/Midterm exam/FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No. 55**	**Date**	**13-06-2021**

Course Code	Course Title	L	T	P	J	C
CBS1901	Technical Answers for Real World Problems (TARP)	1	0	0	4	2
Pre-requisite	115 Credits Earned	Syllabus version				
		v. 1.0				

Course Objectives:

1. To help students to identify the need for developing newer technologies for industrial/societal needs
2. To train students to propose and implement relevant technology for the development of the prototypes / products
3. To make the students learn to the use the methodologies available for analyzing the developed prototypes / products

Expected Course Outcome:

At the end of the course, the student will be able to

1. Identify real life problems related to society
2. Apply appropriate technology(ies) to address the identified problems using engineering principles and arrive at innovative solutions

Module1		15 hours

1. Identification of real-life problems
2. Field visits can be arranged by the faculty concerned
3. 6 – 10 students can form a team (within the same / different discipline)
4. Minimum of eight hours on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified issue
6. Solution should be in the form of fabrication/coding/modeling/product design/process design/relevant scientific methodology(ies)
7. Consolidated report to be submitted for assessment
8. Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component
9. Project outcome to be evaluated in terms of technical, economic, social, environmental, political and demographic feasibility
10. Contribution of each group member to be assessed
11. The project component to have three reviews with the weightage of 20:30:50

Mode of Evaluation: (No FAT) Continuous Assessment the project done – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews

Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No:61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS1902	Industrial Project	0	0	0	0	1
Pre-requisite	Completion of minimum of Two semesters	Syllabus version				
		v.1.0				

Course Objectives:

The course is designed so as to expose the students to industry environment and to take up on- site assignment as trainees or interns.

Expected Course Outcome:

At the end of this internship the student should be able to:

1. Have an exposure to industrial practices and to work in teams
2. Communicate effectively
3. Understand the impact of engineering solutions in a global, economic, environmental and societal context
4. Develop the ability to engage in research and to involve in life-long learning
5. Comprehend contemporary issues
6. Engage in establishing his/her digital footprint

Contents	4 Weeks

Four weeks of work at industry site.
Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

Recommended by Board of Studies	29-01-2021		
Approved by Academic Council	No:61	Date	18-02-2021

Course Code	Course Title	L	T	P	J	C
CBS1903	Comprehensive Examination	0	0	0	0	1
Pre-requisite	Minimum of 115 credits should be earned	Syllabus version				
		v. 1.0				

Course Objectives:

To evaluate the overall understanding of the students in the core areas of B. Tech CSE and Business Systems

Expected Course Outcome:

At the end of the course, the student will be able to

1. Define, explain, evaluate, and interpret the fundamental knowledge pertaining to the field domain of Computer science and Engineering and apply that essential knowledge to the field of Business systems.

Module:1	Programming in C, Object Oriented Programming, Data Structures and Algorithms

C fundamentals – Iterations, Arrays-Pointers, Functions, Structures. C++ classes, Objects, Inheritance, Virtual function- Exception Handling-Generic Templates-Files. Asymptotic Notations- The Big-O, Omega and Theta notation- Stack, Queue, Linked List, Applications of Stack, Queue, and Linked List. - Tree, Binary Tree, Tree Traversals, Binary Search Tree- Graph, Minimum Spanning Tree, Shortest Path Algorithm-Searching - Binary, Linear, BFS, DFS-. Sorting - Insertion, Selection, Shell, Quick and Merge Sort.

Module:2	Design and analysis of Algorithms, Computer Organization and Architecture, Formal languages and Automata theory

Classes of complexity, Analyzing the Time and Space complexity- Iterative and recursive, Algorithmic strategies: Brute force, Greedy, Dynamic programming, Graph algorithms: DFS, BFS, MST, Shortest path algorithm. Instructions-Addressing Modes-Instruction Pipelining-Data Representation-Characteristics of Memories- Memory Hierarchy-Cache Memory- I/O fundamentals- I/O Techniques -Direct Memory Access - Interrupts RAID architecture-Flynn's classification. Finite Automata-Deterministic Finite Automata, Non- Deterministic Finite Automata-Equivalence of NFA and DFA-Applications of NFA-Finite Automata with Epsilon Transition- Regular Languages, Building Regular Expressions, DFA to Regular Expressions-Pumping Lemma for Regular Language-Applications of Pumping Lemma-Context Free Grammar-Derivations and Definitions-Language of a Grammar, Inferences and Ambiguity-Sentential Forms-Construction and Yield of a Parse Tree-PDA-Acceptance by Final State-PDA-Acceptance by Empty Stack-Turing Machine and Halting Problem-Multitape Turingmachines.

Module:3	Principles of Operating Systems, Database systems, Software Engineering Methodologies

Operating System Services, OS Types, Process, System Calls, CPU Scheduling Algorithms, Inter-Process Communication, Deadlock, Memory Allocation, Virtual Memory, Paging, Segmentation, Page Replacement Algorithms, File Allocation Methods, Directory Implementation Methods, I/O Devices, Disk Scheduling algorithms. Data Abstraction, Data Independence, Entity-Relationship Model, Relational Model,

Integrity Constraints, Functional Dependencies, Normal Forms, Dependency Preservation, Relational Algebra, Query Optimization, Transaction Processing, Concurrency Control and Recovery Techniques, Database Storage Strategies, Authentication and Authorization. Process Models- Cost benefit Analysis- COCOMO model- DFD- ER-Design models- Object Oriented Design-Testing- Levels of Testing- Software Project Management-Project Scheduling-Risk Analysis-Quality Metrics- Configuration Management.

Module:4	**Computer Networks, Information security**
Computer networks and distributed systems, Classifications of computer networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN, Bandwidth utilization, Error Detection and Error Correction, Flow Control and Error control protocols, Logical addressing, UDP,TCP, Congestion Control, Quality of Service (QoS), DNS, DDNS, TELNET, EMAIL, FTP, WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography. Confidentiality, integrity and availability - Discretionary, mandatory, roll-based and task-based models - Spatio-temporal models - Confidentiality policies, integrity policies, hybrid policies - Control of access and information flow - Data privacy, introduction to digital forensics – Security Architecture (Operating Systems, Database)	

Module:5	**Introduction to IP management and Entrepreneurship, Fundamentals of Management, Marketing Research & Marketing management, Financial management**
Strategic Management, Business Processes and Capabilities-based Approach to Strategy, Five Forces of Industry Attractiveness that Shape Strategy, Mergers & Acquisitions, Corporate Governance, Leadership Styles, Change Management, Contribution of Management Thinkers: Taylor, Fayol, Elton Mayo etc., Work Stress and Stress Management, Organizational structure, Organizational Culture, Managerial Ethics, Corporate social responsibility, Attributes of a leader, Contemporary issues in management, Concept of IP Management, Use in marketing, Debt, Venture Capital and other forms of Financing, Types of Intellectual Property, Elements of Marketing Mix, Analyzing needs & trends in Environment - Macro, Economic, Political, Technical & Social, Product Life cycle concept, New Product development & strategy, Marketing Channels in retailing, Marketing Communication, Marketing Research Techniques, Strategy and Planning for Internet Marketing, Relationship, networks and customer relationship management, Business to Business marketing strategy, Financial Environments, The Capital Asset Pricing Model (CAPM), Analysis in leverage study.	

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CBS1904	Capstone Project	0	0	0	0	12
Pre-requisite	As per the academic regulations	Syllabus version				
		v. 1.0				

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable process so as to enhance the technical skill sets in the chosen field.

Expected Course Outcome:

At the end of the course the student will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing
5. Synthesize the results and arrive at scientific conclusions / products / solution
6. Document the results in the form of technical report / presentation

Contents

1. Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Can be individual work or a group project, with a maximum of 3 students.
4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
5. Carried out inside or outside the university, in any relevant industry or research institution.
6. Publications in the peer reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission

Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No:61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
CHY1701	Engineering Chemistry	3	0	2	0	4
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
		v. 1.0				

Course Objectives:

1. To impart technological aspects of applied chemistry
2. To lay foundation for practical application of chemistry in engineering aspects

Expected Course Outcome:

1. 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

Module: 1	Water Technology	5 hours

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

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 Filtratio - chlorination; Domestic water purification – Candle filtration- activated carbon filtration; Disinfection methods- Ultrafiltration, UV treatment, Ozonolysis, Reverse Osmosis; Electro dialysis.

Module: 3	Corrosion	6 hours

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

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

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
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 NOX; Knocking in IC engines - Octane and Cetane number – Anti-knocking agents.		

Module: 7	Polymers	6 hours
Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - ABS, PVC, PTFE and Bakelite; Compounding of plastics: molding of plastics for Car parts, bottle caps (Injection molding), Pipes, Hoses (Extrusion molding), Mobile Phone Cases, Battery Trays, (Compression molding), Fiber reinforced polymers, Composites (Transfer molding), PET bottles (blow molding); 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.	Sashi Chawla, A Text book of Engineering Chemistry, Dhanpat Rai Publishing Co., Pvt. Ltd., Educational and Technical Publishers, New Delhi, 3rd Ed., 2015.
2.	O.G. Palanna, McGraw Hill Education (India) Pvt. Ltd., 9th Reprint, 2015.
3.	B. Sivasankar, Engineering Chemistry 1st Ed., McGraw Hill Education, 2008
4.	"Photovoltaic Solar Energy: From Fundamentals to Applications", Angèle Reinders et al., Wiley publishers, 2017.

Reference Books

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 Experiments

1.	Water Purification: Estimation of water hardness by EDTA method and its removal by ion-exchange resin	3 hours
2.	Water Quality Monitoring:	6 hours
	Assessment of total dissolved oxygen in different water samples by Winkler's method	
3.	Estimation of sulphate/chloride in drinking water by conductivity method	
4/5.	Material Analysis: Quantitative colorimetric determination of divalent metal ions of Ni/Fe/Cu using conventional and smart phone digital-imaging methods	6 hours
6.	Arduino microcontroller-based Sensor monitoring pH/temperature/conductivity in samples	3 hours
7.	Iron in carbon steel by potentiometry	3 hours

8.	Construction and working of an Zn-Cu electrochemical cell	3 hours
9.	Determination of viscosity-average molecular weight of different natural/synthetic polymers	6 hours
10.	Preparation/demonstration of a working model relevant to syllabus. Ex. 1. Construction and working of electrochemical energy system – students should demonstrate working of the system. 2. Model corrosion studies (buckling of Steel under applied load). 3. Demonstration of BOD/COD	Non-contact hours

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**31-05-2019**		
Approved by Academic Council	**No:55**	**Date**	**13-06-2019**

Course Code	Course Title	L	T	P	J	C
CSE1008	Programming in C	3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To impart essential problem-solving skills through general problem-solving concepts.
2. To provide basic knowledge on programming essentials using C as implementation tool.
3. To introduce the Unix file system interface and introduce various programming methodsusing C.

Expected Course Outcome:

After completion of this course, students will be able to:

1. Propose solutions for a given problem using algorithm and flowchart designs.
2. Infer the fundamental programming elements in C language and learn to apply basiccontrol structures in C.
3. Visualize the capabilities of modular programming approach in C and demonstrate thesame in the real world scenario.
4. Understand the basic principles of pointers and their association with various data structures during implementations.
5. Demonstrate the applications of structures and unions.
6. Apply various input, output and error handling functions in C while solving the given problem through unix system interface.
7. Showcase the attained knowledge by applying them to solve various real-world problems.

Module:1	General Problem-Solving Concepts	3 hours

Algorithm and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops. Imperative languages: Introduction to imperative language; syntax and constructs of a specific language (ANSI C)

Module:2	Types Operator and Expressions with discussion of variable naming and Hungarian Notation	4 hours

Variable Names, Data Type and Sizes (Little Endian Big Endian), Constants, Declarations, Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation

Module:3	Control Flow with discussion on structured and unstructured programming	7 hours

Statements and Blocks, If-Else-If, Switch, Loops - while, do, for, break and continue, Goto Labels, structured and un- structured programming

Module:4	**Functions and Program Structure with discussion on standard library**	**6 hours**
Basics of functions, parameter passing and returning type, C main return as integer, External,Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, Preprocessor, Standard Library Functions and return types		
Module:5	**Pointers and Arrays**	**8 hours**
Pointers and address, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional array and Row/column major formats, Initialisation of Pointer Arrays, Command line arguments, Pointer to functions, complicated declarations and how they are evaluated.		
Module:6	**Structures & Input/Output**	**9 hours**
Basic Structures, Structures and Functions, Array of structures, Pointer of structures, Self-referral Structures, Table look up, Typedef, Unions, Bit-fields. Input and Output: 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		
Module:7	**Unix system Interface & Programmingmethods**	**6 hours**
File Descriptor, Low level I/O - read and write, Open, create, close and unlink, Random access -Iseek, Discussions on Listing Directory, Storage allocator. Programming Method: Debugging, Macro, User Defined Header, User Defined Library Function,makefile utility.		
Module:8	**Case Studies on Complex problem Solving**	**2 hours**
Total Lecture hours:		**45 hours**

Text Book(s)	
1.	B. W. Kernighan and D. M. Ritchi, "The C Programming Language", Second Edition, Pearson, June 2015.
2.	Gary J Bronson, "ANSI C Programming", Fourth Edition, Cengage Learning India Private Limited; Fourth edition, 2016.
3.	B. Gottfried, "Programming in C", Second Edition, Schaum Outline Series, Tata Mc-Graw Hill Publishers, 1996.
Reference Books	
1.	Herbert Schildt, "C: The Complete Reference", Fourth Edition, McGraw Hill, 2000.
2.	Yashavant Kanetkar, "Let Us C", BPB Publications, 2017.

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

List of Challenging Experiments (Indicative)		
1.	Algorithm and flowcharts of small problems like GCD	2 hours
2.	Small but tricky codes (use of operators and expressions)	3 hours
3.	Solving sequences (applications of control structures)	4 hours
4.	Proper parameter passing (User defined functions)	3 hours
5.	Command line Arguments (Understanding main( ))	2 hours
6.	Variable parameter (Pointers and Arrays)	3 hours
7.	Pointer to functions (Pointer and functions)	3 hours
8.	User defined header (Creation of headers)	3 hours
9.	Make file utility (unix make file)	2 hours
10.	Multi file program and user defined libraries (Use of pre-processor directives)	3 hours
11.	Interesting substring matching / searching programs (String matching andsearching)	2 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment: CAT / Assignment / Quiz / FAT / Lab			
Recommended by Board of Studies	**16-02-2019**		
Approved by Academic Council	**No. 55**	**Date**	**13-06-2019**

Course code	Course title	L	T	P	J	C
ENG 1013	Business Communication & Value Science – I	1	0	2	0	2
Pre-requisite	Basic Knowledge of high school English	Syllabus version				
		v. 1.0				

Course Objectives:

1. To understand the concepts of life skills and its importance
2. To motivate students to look within and create a better version of self.
3. To introduce them to key concepts of values, life skills and business communication

Expected Course Outcome:

1. Understand the need for life skills and values.
2. Acquaint the learners with basics of pronunciation
3. Recognize own strengths and opportunities
4. Integrate the life skills to different situations
5. Comprehend the basic tenets of communication
6. Apply the basic communication practices in different types of communication.

Module:1	Elementary Grammar & Vocabulary Enrichment	2 hours

Understanding basic grammar-Parts of Speech; reading newspapers for vocabulary development - Understanding Tenses& Common mistakes in everyday conversation.

Module:2	Phonics in English	2 hours

Sounds – Vowels and Consonants – Minimal Pairs- Consonant Clusters- Past Tense Marker and Plural Marker.Activity: Worksheets, Exercises

Module:3	Communication Skills	2 hours

Overview of Communication Skills Barriers of communication, Types of communication- Verbal and Non-verbal &Effective communication.

Module:4	Introduction to Life Skills	2 hours

Stress management, working with rhythm and balance, teamwork - Pursuit of Happiness. What are the skills and values you can identify, what can you relate to?

Module:5	Art of Public Speaking	2 hours

Impromptu, Importance of Non-verbal Communication, Technical Talks, Dynamics of Professional Presentations – Individual & Group

Module:6	Writing Skill	2 hours

Summary writing, story writing and creating a Podcast

Module:7	Correspondence and Career Development	3 hours

Letter-Formal, Email &Application Writing Activity: Compose letters; Emails, leave applications - Resume Preparation/**CV**– start writingyour comprehensive CV including every achievement inyour life. Video Profile - Activity: Preparation of Video Profile.

Module: 8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**15 hours**
Lab Experiments:		
1	Listening: Casual and Academic	2 hours
2	Speaking: Socializing Skills - Introducing Oneself- His / Her Goals & SWOT	4 hours
3	Group Discussion: Factual, controversial and abstract issues	4 hours
4	Presentation skill: JAM, Narrating a story/anecdote	3 hours
5	Writing: Travelogue	4 hours
6	Public Speaking: Extempore /Monologues	4 hours
7	Roleplay: Understanding Inter and Cross-Cultural Communication Nuances	2 hours
8	Life skill: Community service-work with an NGO and make a presentation -Roleplay	2 hours
9	Ted-talks: Famous Personalities motivational speakers – sports celebrities	2 hours
10	Soft skills - Mock Job/Placement Interviews/ Video Resume	3 hours
	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Kumar.Sanjay & Pushplata, Communication Skills, 2nd Edition, OUP, 2015	
2.	Koneru, ArunaProfessional Speaking Skills, OUP, 2015.	
Reference Books		
1.	Mc'carthy,Michael &O'dell,Felicity, English Vocabulary in use,CUP,2010	
2.	SarojHiremath, Saroj, Business communication, NiraliPrakashan, 2018.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT		
Recommended by Board of Studies	**16-02-2019**	
Approved by Academic Council	**No. 55**	**Date** **13-06-2019**

Course code	Course title	L	T	P	J	C
ENG 1014	Business Communication & Value Science – II	1	0	2	0	2
Pre-requisite		Syllabus version				
		v. 1.0				

Course Objectives:

1. To develop effective writing, reading, presentation and group discussion skills.
2. To help students identify personality traits and evolve as a better team player.
3. To introduce them to key concepts of morality, behaviour & beliefs and diversity & inclusion

Expected Course Outcome:

1. Integrate electronic/social media to share concepts and ideas
2. Acquire technical writing skills
3. Apply different tools for quick reading.
4. Understand the basic concepts of Morality and Diversity
5. Articulate opinions on a topic with the objective of influencing others
6. Demonstrate the basics of presentation and effective writing skills

Module:1	Public Speaking and Presentation Skills	3 hours

Participate in 'Join Hands Movement'. Individual identification of social issues - Each Individual chooses one particular social issue which they would like to address - Common errors, punctuation rules and words often confused.

Module:2	Lucid Writing	3 hours

Encourage the students to go through the links given about Catherine Morris and Joanie McMahon's writing techniques - Speed Reading session: Introduction to skimming and scanning; practice the same.

Module:3	Communication Skills	3 hours

Team work and how individuals contribute- Belbin's 8 Team Roles and Lindgren's Big 5 personality traits - Belbin's 8 team player styles

Module:4	Soft Skills	3 hours

Reviewing a book, a video, a film -Values and Life Skills: TCS values

Module:5	Data Interpretation	3 hours

Interpretation of Data & Transcoding

	Total Lecture hours:	15 hours

Lab Experiments (CO 6)

1	Debates: Social issues and Ethical values	4 hours
2	E-magazine: Planning and Designing	6 hours
3	Design a logo: Creating Vision, Mission, Value statement, tagline	4 hours
4	Soft skills: Role playson social issues	2 hours

5	Soft Skills : Discussion on social issues	2 hours
6	Presentation skills: Understanding diversity: PPT presentations	4 hours
7	Report Writing: Role of NGO: a visit to the sight for a hands-on experience and submit a report	4 hours
8	Resume: Video resume	4 hours
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Raman, Meenakshi& Sangeeta Sharma. Technical Communication: Principles and Practice, 3rd edition, Oxford University Press, 2015.
Reference Books	
1.	Kalam, A.A. (2015). Guiding Souls: Dialogues on the purpose of Life.PrabhatPrakashan
2.	Alred, G. J., Brusaw, C. T., &Oliu, W. E. (2011). Handbook of Technical Writing, Tenth Edition (10th ed.). St. Martin's Press
3	Sherman, Barbara.(2014).Skimming and Scanning Techniques.Liberty University Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**16-02-2019**		
Approved by Academic Council	**No. 55**	**Date**	**13-06-2019**

Course code	Course title	L	T	P	J	C
ENG 1017	Business Communication & Value Science – III	1	0	2	0	2
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To develop technical writing skills
2. To familiarize learners with Self-analysis techniques like SWOT & TOWS
3. To introduce students to key concepts of Pluralism & cultural spaces, Cross-cultural Communication and Science of Nation building.

Expected Course Outcome:

1. Apply the basic principles of SWOT & life positions.
2. Write effective sentences by exposure to grammatical rules
3. Understand the concepts of Global, glocal and trans locational
4. Define and recognize the importance of Artificial Intelligence
5. Analyze the tools of technical writing
6. Exhibit understanding of diversity and cross-cultural communication

Module:1	**SWOT Vs. TOWS**	**2 hours**

The Balancing Act (Self Analysis) **-** Basic principles of SWOT & life positions. Ted talks on biomimicry

Module:2	**English Grammar & Vocabulary**	**2 hours**

Error Detection, Voice (Active & passive) Text Completion (Closed/ open)

Module:3	**Pluralism in cultural spaces**	**2 hours**

Awareness and respect for pluralism in cultural spaces Theory/Discussion using Phir Miley Sur Mera Tumhara

Module:4	**Global, Glocal and translocational cross-cultural communication**	**2 hours**

Identify the common mistakes made in cross-cultural communication. Verbal and non-verbal communication (approach is through Ted and YouTube videos).

Module:5	**Technical Writing**	**2 hours**

a) Report writing -Basic rules of Report writing through examples
b) Technical Proposal - "How will a voice assistant evolve in 25 years from now?"

Module:6	**Motivation**	**2 hours**

Maslow's theory - Recognize how motivation helps real life - Leverage motivation in real-life scenarios

Module:7	**Role of Science in nation building**	**2 hours**

Introduction to Role of science in nation building- Discussion through Augmented Reality, Role of science post- independence

Module:8	**Contemporary guest lecture**	**1 hour**
	Total Lecture hours:	**15 hours**

Lab Experiments		
1	Speaking -Applying SWOT in real life scenarios/Create your SWOT	4 hours
2	Role Play/ Skit -Global/Glocal/Translocational culture	4 hours
3	Listening -Motivational Talk	2 hours
4	Writing - Importance of Artificial Intelligence. / Practical technology	4 hours
5	Reading & Summarizing - activity on identifying and leveraging motivation /Maslow's Theory	4 hours
6	Speaking –Cross Cultural Communication: PPT presentations	4 hours
7	Group Discussion - the role of scientists and mathematicians from ancient India.	4 hours
8	Creative Writing (Poster Presentation) -Gender awareness campaign	4 hours
	Total Laboratory hours:	**30 hours**

Text Book(s)	
1.	Kumar, Sanjay and Pushp Lata. English Language and Communication Skills for Engineers, Oxford University Press, India, 2018.
Reference Books	
1.	Pringle, A. S., & O'Keefe, S. S. (2009). Technical Writing 101: A Real-World Guide to Planning and Writing Technical Content (3rd ed.). Scriptorium Publishing Services, Inc.
2.	Alred, G. J., Brusaw, C. T., &Oliu, W. E. (2011). Handbook of Technical Writing, Tenth Edition (10th ed.). St. Martin's Press.
3.	Reynolds, S., Valentine, D., &Munter, M. M. (2019). Guide to Cross-Cultural Communications (2nd Edition) (Guide to Series in Business Communication) (2nd ed.). Pearson
4.	Hurn, B., & Tomalin, B. (2016). Cross-Cultural Communication: Theory and Practice (1st ed. 2013 ed.). Palgrave Macmillan.
Web References:	
1	Examples of Technical Writing for Students https://freelance-writing.lovetoknow.com/kinds-technical-writing
2	11 Skills of a Good Technical Writer https://clickhelp.com/clickhelp-technical-writing-blog/11-skills-of-a-good-technical-writer/
3	13 benefits and challenges of cultural diversity in the workplace https://www.hult.edu/blog/benefits-challenges-cultural-diversity-workplace/
Online Resources:	
1	https://youtu.be/CsaTslhSDI
2	https://m.youtube.com/watch?feature=youtu.be&v=e80BbX05D7Y
3	https://m.youtube.com/watch?v=dT_D68RJ5T8&feature=youtu.be

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
ENG1018	Business Communication and Value Science - IV	1	0	2	0	2
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To recognize the best practices of communicative writing
2. To understand the importance of emotional intelligence and diversity in personal and professional lives
3. To acquaint the learners on corporate etiquettes & corporate social responsibility

Expected Course Outcome:

4. Excel in communicative writing in real life scenarios.
5. Recognize the importance of corporate social responsibility (CSR)
6. Assess the impact of conflicts and list the basic guidelines required to manage conflicts
7. Relate to Emotional Intelligence in personal and professional life.
8. Identify the best time management practices and apply in diverse situations
9. Demonstrate advanced level communication skills

Module:1	Communicative Writing	2 hours
Principles of Communicative Writing, Formal and Business letters, Writing SOP		

Module:2	Corporate Social Responsibility (CSR)	2 hours
Ubuntu story – A story to introduce the concept of social responsibility. Attributes required for work and life Qualities of a good team member: a) Resilience, b) Flexibility, c) Strategic thinking & planning d) Decision making, e) Resolving conflicts		

Module:3	Understanding conflicts	2 hours
Meaning and definition of conflict; reasons for conflict; negative and positive impact of conflict, Tips to manage conflict		

Module:4	Business Communication	2 hours
Business idioms and corporate terms - handouts of common business idioms and guide them to download the TCS BizVocab on their smartphones.		

Module:5	Time management	2 hours
Basic concepts of Time Management Importance of Time Management for Better Life Style		

Module: 6	Corporate Etiquette & Communication	2 hours
Importance of Etiquette in business and everyday life, Components of Etiquette –Netiquette and standards for online writing, Cell Phone & Telephone Etiquette		

Module 7	Stress Management Techniques	2 hours
Basic practices to manage stress, 4A's of stress management, Relaxation techniques		

Module 8	**Contemporary Guest Lecture**	**1 hour**
	Total Lecture hours:	**15 hours**

Lab Experiments:		
1	Listening - CSR story & CSR activity of Tata Steel, Microsoft, Google, TCS, Starbucks, Titan, Tata Chemicals and TOMS Shoes	4 hours
2	Speaking - Public speaking at work place and best practices of public speaking/ Presenting a selected speech by an eminent leader.	4 hours
3	Reading- Cloze test on corporate etiquettes	3 hours
4	Communicative writing- drafting business mails/ Organizing work place events through mails	4 hours
5	Listening - Case studies of Conflict resolution/ Videos on cultural diversity at work place- advantages and challenges	3 hours
6	Speaking - Conflict management- Presentation skills / Effective time management- extempore/ presenting a pitch	4 hours
7	Reading & summarizing - Time management activities : Time squared activity / Circadian Rhythm	4 hours
8	Narrative Writing - Who am I? (Image Management, Building a perfect image) / Exploring Self-awareness and social awareness through Narrative essay	4 hours
	Total Laboratory hours:	30 hours

Text Book(s)	
1.	Raman, Meenakshi & Sangeeta Sharma. Technical Communication: Principles and Practice, 3rd edition, Oxford University Press, 2015.

Reference Books	
1.	Carnegie, D. (2017). How to Develop Self-Confidence and Influence People by Public Speaking (Reissue ed.). Gallery Books
2.	C Muralikrishna & Sunitha Mishra(2011). Communication Skills for Engineers, 2nd edition, NY: Pearson.
3.	Frantisek, Burda(2015). On Transcultural Communication, LAP Lambert Academic Publishing, UK.

Web References:	
1	https://www.tata.com/about-us/tata-group-our-heritage
2	https://economictimes.indiatimes.com/tata-success-story-is-based-on-humanity-philanthropy-and-ethics/articleshow/41766592.cms

Online Resources:	
1	https://youtu.be/reu8rzD6ZAE
2	https://youtu.be/Wx9v_J34Fyo
3	https://youtu.be/F2hc2FLOdhI
4	https://youtu.be/wHGqp8lz36c
5	https://youtu.be/hxS5He3KVEM

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course Code	Course Title	L	T	P	J	C
ENG1901	Technical English - I	0	0	4	0	2
Pre-requisite	Foundation English-II	Syllabus Version				
		v. 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.

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. (1973–2010). 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.	Guptha S C, (2012) Practical English Grammar & Composition, 1st Edition, India: Arihant Publishers
2.	Steven Brown, (2011) Dorolyn Smith, Active Listening 3, 3rd Edition, UK: Cambridge University Press.
3.	Liz Hamp-Lyons, Ben Heasley, (2010) Study Writing, 2nd Edition, UK: Cambridge University Press.
4.	Kenneth Anderson, Joan Maclean, (2013) Tony Lynch, Study Speaking, 2nd Edition, UK: Cambridge, University Press.
5.	Eric H. Glendinning, Beverly Holmstrom, (2012) 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, (2012) 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	**12 hours**
2.	Sequencing Ideas and Writing a Paragraph	**12 hours**
3.	Reading and Analyzing Technical Articles	**8 hours**
4.	Listening for Specificity in Interviews (Content Specific)	**12 hours**
5.	Identifying Errors in a Sentence or Paragraph	**8 hours**
6.	Writing an E-mail by narrating life events	**8 hours**
	Total Laboratory Hours	**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	**No. 55**	**Date:**	**13-06-2019**

Course Code	Course Title	L	T	P	J	C
ENG1902	Technical English - II	0	0	4	0	2
Pre-requisite	71% to 90% EPT score	Syllabus Version				
		v. 1.0				

Course Objectives:

1. To acquire proficiency levels in LSRW skills on par with the requirements for placementinterviews 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

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, MotivationalSpeeches in UK/ US/ global English accents. Activity: Note-making and Interpretive exercises		
Module:6	**Academic Writing and Editing**	**6 hours**
Writing: Editing/ Proof reading symbols Citation Formats Structure of an Abstract and Research Paper Activity: Writing Abstracts and research paper; Work with Editing/ Proof reading 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, ResearchTalks, 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, 2013.	
2.	Balasubramanian, T. English Phonetics for the Indian Students: A Workbook. Laxmi Publications, 2016.	
3.	Philip Seargeant and Bill Greenwell, From Language to Creative Writing. Bloomsbury Academic, 2013.	
4.	Krishnaswamy, N. Eco-English. Bloomsbury India, 2015.	
5.	Manto, Saadat Hasan. Selected Short Stories. Trans. Aatish Taseer. Random House India, 2012.	
6.	Ghosh, Amitav. The Hungry Tide. Harper Collins, 2016.	
7.	Ghosh, Amitav. The Great Derangement: Climate Change and the Unthinkable. Penguin Books, 2016.	
8.	The MLA Handbook for Writers of Research Papers, 8th Edition. 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")
/www.esl-lab.com/; www.bbc.co.uk/learningenglish/;
/www.bbc.com/news;
/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	12 hours
2.	Writing minutes of meetings	10 hours
3.	Writing an abstract	10 hours
4.	Listening to motivational speeches and interpretation	10 hours
5.	Cloze Test	6 hours
6.	Writing a proposal	12 hours
	Total Laboratory Hours	**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	**No. 55**	**Date: 13-06-2019**

Course Code	Course title	L	T	P	J	C
ENG1903	Advanced Technical English	0	0	2	4	2
Pre-requisite	Greater than 90 % EPT score	Syllabus Version				
		v.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

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 discussionon 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, 2011 Kindle edition	
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 AcademicPublishing, UK.	
5.	Geever, C. Jane. The Foundation Center's Guide to Proposal Writing, 5th Edition, 2007, Reprint 2012 The Foundation Center, USA.	
6.	Young, Milena. Hacking Your Statement of Purpose: A Concise Guide to Writing Your SOP, 2014 Kindle Edition.	
7.	Ray, Ratri, William Shakespeare's Hamlet, The Atlantic Publishers, 2011.	
8.	C Muralikrishna & Sunitha Mishra, Communication Skills for Engineers, 2nd edition, NY: Pearson, 2011.	
Mode of Evaluation: Quizzes, Presentation, Discussion, Role Play, Assignments		
List of Challenging Experiments (Indicative)		
1.	Enacting a court scene – Speaking	6 hours
2.	Watching a movie and writing a review	4 hours
3.	Trans-cultural – case studies	2 hours
4.	Drafting a report on any social issue	6 hours
5.	Technical Presentation using web tools	6 hours
6.	Writing a research paper	6 hours
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	**No. 55**	**Date:**	**13-06-2019**

Course Code	Course Title	L	T	P	J	C
HUM1021	ETHICS AND VALUES	2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v. 1.1				

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
   Understand various social problems and learn to act ethically
2. Understand the concept of addiction and how it will affect the physical and mental health
3. 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
4. Identify the main typologies, characteristics, activities, actors and forms of cybercrime

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	5 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	3 hours

Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention

Module:6	Personal and Professional Ethics	4 hours

Dishonesty - Stealing - Malpractices in Examinations – Plagiarism

Module:7	Abuse of Technologies	3 hours

Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking websites		
Module:8	**Contemporary issues:** Guest lectures by Experts	**2 hours**
	Total Lecture hours:	**30 hours**

Reference Books	
1.	Dhaliwal, K.K , "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts, 2016, Writers Choice, New Delhi, India.
2.	Vittal, N, "Ending Corruption? - How to Clean up India?", 2012, Penguin Publishers, UK. Pagliaro,
3.	L.A. and Pagliaro, A.M, "Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological, Developmental and Clinical Considerations", 2012, Wiley Publishers, U.S.A. Pandey, P. K(2012), "Sexual Harassment and Law in India", 2012, Lambert Publishers, Germany.

Mode of Evaluation: CAT, Assignment, Quiz, FAT and Seminar			
Recommended by Board of Studies	**26-07-2017**		
Approved by Academic Council	**No. 46**	**Date**	**24-08-2017**

Course code	Course Title	L	T	P	J	C
MAT1017	Probability and Statistics	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

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 relationships of real-time data.
3. To apply estimation and testing methods to make inference and modeling techniques for decision making.

Expected Course Outcome: At the end of this course the students are expected to

1. Have an understanding of the probability concepts.
2. Analyze the problems connected with statistics.
3. Understand how to make the transition from a real problem to a probability model for that problem.
4. Expose students to practical applications.

Module:1	**Probability:**	**6 hours**

Concepts of experiments, sample space, event. Definition of combinatorial probability. Conditional probability, Bayes Theorem.

Module:2	**Random Variables:**	**6 hours**

Random variables, Probability distributions: Discrete & continuous distributions, Mathematical expectation and its properties, Moments (including variance) and their properties, interpretation, Moment generating function.

Module:3	**Distributions:**	**8 hours**

Binomial, Poisson and Geometric distributions, Uniform, Exponential, Normal, Chi-square, t, F distributions.

Module:4	**Statistics:**	**6 hours**

Definition of Statistics, Basic objectives, Applications in various branches of science with examples.
Collection of Data: Internal and external data, Primary and secondary data.
Population and sample, Representative sample.

Module:5	**Data Analysis:**	**5 hours**

Classification and tabulation of univariate data, graphical representation, Frequency curves.

Module:6	**Descriptive Measures:**	**5 hours**

Descriptive measures - central tendency and dispersion. Bivariate data. Summarization, marginal and conditional frequency distribution.

Module:7	**Calculus**:	**7 hours**

Basic concepts of Differential and integral calculus, application of double and triple integral.

Module:8	**Expert Lecture**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1.	Introduction of Probability Models, S. M. Ross, Academic Press, N.Y.
2.	Fundamentals of Statistics, vol. I & II, A. Goon, M. Gupta and B. Dasgupta, World Press.
3	Higher Engineering Mathematics, B. S. Grewal, Khanna Publication, Delhi.
Reference Books	
1.	A first course in Probability, S. M. Ross, Prentice Hall.
2.	Probability and Statistics for Engineers, (Fourth Edition), I. R. Miller, J.E. Freund and R. Johnson, PHI.
3	Introduction to the Theory of Statistics, A. M. Mood, F.A. Graybill and D.C. Boes, McGraw Hill Education.
4	Advanced Engineering Mathematics, (Seventh Edition), Peter V. O'Neil, Thomson Learning.
5	Advanced Engineering Mathematics, (Second Edition) M. D. Greenberg, Pearson Education.
6	Applied Mathematics, Vol. I & II, P. N. Wartikar and J. N. Wartikar, VidyarthiPrakashan.

Mode of Evaluation: Assignments, Quiz, Continuous assessments, Seminar and Final assessment test

Recommended by Board of Studies	**10-09-2019**		
Approved by Academic Council	**No.56**	**Date**	**24-09-2019**

Course Code	Course Title	L	T	P	J	C
MGT2001	Introduction To Innovation, Ip Management & Entrepreneurship	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. Appreciate innovation as core business process, and ability to apply it to the growth of an organization.
2. Recognize the role of entrepreneurship in giving the organization a sustainable competitive advantage.
3. Awareness of the concept and types of Intellectual Property Rights and their protection

Expected Course Outcome:

1. Understand the concept and need for innovation in an organization.
2. Appreciate how entrepreneurs can add value to an organization, and give it a sustainable competitive advantage.
3. Know the concept of IPR, their different types, and how to protect them.

Module:1	Introduction on Innovation	6 hours

Innovation as a core business process, Sources of innovation, Knowledge push vs. need pull innovations.

Module:2	Building an Innovative Organization	9 hours

Creating new products and services, exploiting open innovation and collaboration, use of innovation for starting a new venture

Class Discussion- Innovation: Co-operating across networks vs. 'go-it-alone' approach

Module:3	Entrepreneurship	5 hours

Opportunity recognition and entry strategies-Entrepreneurship as a Style of Management-Maintaining Competitive Advantage- Use of IPR to protect Innovation

Module:4	Entrepreneurship- Financial Planning	5 hours

Financial Projections and Valuation-Stages of financing - Debt, Venture Capital and other forms of Financing

Module:5	Essentials of Intellectual Property Rights (IPR)	4 hours

Introduction and the economics behind development of IPR: Business Perspective - IPR in India – Genesis and Development - International Context - Concept of IP Management, Use in marketing.

Module:6	Types of Intellectual Property	4 hours

Patent- Procedure, Licensing and Assignment, Infringement and Penalty- Trademark- Use in marketing, example of trademarks- Domain Name-Geographical Indications- Basics of GI, Purpose of protecting them.

Module:7	Intellectual Property & Copyrights	9 hours

Copyright- Introduction, Industrial Designs- What is design? How to protect? Class Discussion- Major Court battles regarding violation of patents between corporate companies.		
Module:8	**Contemporary issues**	**2 hours**
Guest lectures by entrepreneurs		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Business Transformations in the Era of Digitalization (2019), Aloulou, W, IGI Global.
2.	Innovative science teaching (2019), Mohan, R. (2019). PHI Learning Pvt. Ltd.
Reference Books	
1.	Research on Entrepreneurship, Innovation, and Internationalization, Pereira, E. T. IGI Global.
2.	Creative marginality: Innovation at the intersections of social sciences (2019), Dogan, M Routledge.
3.	International intellectual property in an integrated world economy (2019), Abbott, F. M., Cottier, T., & Gurry, F. (2019), Aspen Publishers.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	**29-01-2021**		
Approved by Academic Council	**No. 61**	**Date**	**18-02-2021**

Course code	Course title	L	T	P	J	C
PHY1005	Modern Physics	3	0	2	0	4
Pre-requisite		Syllabus version				
		v. 1.0				

Course Objectives:

1. The course work aims in imparting fundamental knowledge of oscillations, optics, quantum mechanics, crystal structures and laws of thermodynamics which are essential in understanding and explaining engineering devices.

Expected Course Outcome:

1. Demonstrate different law of thermodynamics, their significance and calculate entropy for a given process.
2. Analyse the behavior of a damped harmonic oscillator
3. Explain the phenomenon of interference, diffraction and polarisation and utilise it for engineering applications
4. Describe and make use of the Maxwells equation of electromagnetism
5. Use the basic principles of Quantum mechanics to identify the wave function & understand different crystal structures
6. Explain the different types of laser, fiber optic and their applications

Module:1	Thermodynamics:	6 hours

Zeroth law of thermodynamics, first law of thermodynamics, brief discussion on application of 1st law, second law of thermodynamics and concept of Engine, entropy, change in entropy in reversible and irreversible processes, third law of thermodynamics.

Module:2	Oscillations	6 hours

Periodic motion, simple harmonic motion, characteristics of simple harmonic motion, vibration of simple spring-mass system. Damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, Resonance definition and concept.

Module:3	Interference-principle and young's experiment	7 hours

Principle of superposition, Young's experiment, Newton's rings, Diffraction (Qualitative), Diffraction Grating, Difference between interference and diffraction. Polarization (Qualitative) Temporal and Spatial Coherence.

Theory of interference fringes, types of interference, Fresnel's prism, Newton's rings, Diffraction, Difference between interference and diffraction, diffraction grating.

Module:4	Electromagnetisms and Maxwell's Equations	6 hours

Maxwell's (Differential and Integral forms) equation in vacuum and non-conducting medium, Continuity equation for current densities. Gauss law for electrostatics and magnetostatics, Ampere law and displacement current, EM waves. Concept of Light.

Module:5	Quantum Mechanics and Semiconductors	6 hours
Introduction - Planck's quantum theory, Matter waves, de-Broglie wavelength, Heisenberg's Uncertainty principle, time independent and time dependent Schrödinger's wave equation, Physical significance of wave function, Particle in a one dimensional potential box, Heisenberg Picture. Semiconductor Physics - conductor, semiconductor and Insulator; Basic concept of Band theory.		
Module:6	**Crystallography**	**6 hours**
Basic terms, types of crystal systems, Bravais lattices, miller indices, d spacing, Conductor, Semiconductor and Insulator (Qualitative)		
Module:7	**Laser and Fiber optics**	**6 hours**
Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: Ruby Laser, CO_2 and Neodymium lasers; applications of lasers in engineering. Types of optical fibers, Fiber optics and Applications, Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: Ruby Laser, CO2 and Neodymium lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in engineering. Fiber optics and Applications, Types of optical fibers		
Module:8	**Contemporary issues**	**2 hours**
Guest lectures by entrepreneurs		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Modern Physics, Kenneth S. Krane, 3rd Edition, 2012, ISBN 978-1-1180-6114-5
2. University Physics with Modern Physics, Wolfgang Bauer and Gary Westfall, 2nd edition, 2013, Publisher: McGraw-Hill Companies, Inc., ISBN-13: 9780073513881, ISBN: 0073513881
3. Physics for Scientists and Engineers: A Strategic Approach with Modern Physics, Randall D. Knight, 3rd edition, 2013, ISBN-10: 0321740904, ISBN-13: 978- 0321740908
4. Beiser A, "Concepts of Modern Physics", Fifth Edition, McGraw Hill International.
5. David Halliday, Robert Resnick, Jearl Walker, "Fundamentals of Physics", Wiley.

Reference Books

1. Modern Physics for Scientists and Engineers, Author: Stephen T. Thornton and Andrew Rex, Publisher: Cengage Learning (2012), ISBN-10: 1133103723, ISBN- 13: 978-1133103721
2. Ajoy Ghatak, "Optics" Fifth Edition, Tata McGraw Hill.
   Sears & Zemansky, "University Physics", Addison-Wesley.
   Jenkins and White, "Fundamentals of Optics", Third Edition, McGraw-Hill.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**16-02-2019**		
Approved by Academic Council	**No. 55**	**Date**	**13-06-2019**

UNIVERSITY CORE

B. Tech. Computer Science and Engineering and Business Systems

(in collaboration with TCS)

FLC4097 - Foreign Language Course Basket

Course Code	Course Title	L	T	P	J	C
ESP1001	ESPAÑOL FUNDAMENTAL	2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

The course gives students the necessary background to:

1. Demonstrate Proficiency in reading, writing, and speaking in basic Spanish. Learning vocabulary related to profession, education centres, day today activities, food, culture, sports and hobby, family set up, workplace, market and classroom activities is essential.
2. Demonstrate the ability to describe things and will be able to translate into English and vice versa.
3. Describe in simple terms (both in written and oral form) aspects of their background, immediate environment and matters in areas of immediate need.

Expected Course Outcome:

The students will be able to

1. Remember greetings, giving personal details and Identify genders by using correct articles
2. Apply the correct use of SER, ESTAR and TENER verb for describing people, place and things
3. Create opinion about time and weather conditions by knowing months, days and seasons in Spanish
4. Create opinion about people and places by using regular verbs
5. Apply reflexive verbs for writing about daily routine and create small paragraphs about hometown, best friend and family

Module: 1	Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Profesión	3 hours

Competencia Gramática: Vocales y Consonantes. Artículos definidos e indefinidos (Numero y Genero).
Competencia Escrita: Saludos y Datos personales

Module: 2	Edad y posesión. Números (1-20)	3 hours

Competencia Gramática: Pronombres personales. Adjetivos. Los verbos SER y TENER.
Competencia Escrita: Escribe sobre mismo/a y los compañeros de la clase

Module: 3	Vocabulario de Mi habitación. Colores. Descripción de lugares y cosas	5 hours

Competencia Gramática: Adjetivos posesivos. El uso del verbo ESTAR. Diferencia entre SER y ESTAR.
Competencia Escrita: Mi habitación

Module: 4	Mi familia. Números (21-100). Direcciones.Expresar la hora. Los meses del año.	5 hours

Competencia Gramática: Frases preposicionales. Uso del HAY. La diferencia entre MUY y MUCHO. Uso del verbo GUSTAR
Competencia Escrita: Mi familia. Dar opiniones sobre tiempo

Module: 5	Expresar fechas y el tiempo. Dar opiniones sobre personas y lugares.	5 hours

Competencia Gramática: Los verbos regulares (-AR, -ER, -IR) en el presente. Adjetivosdemostrativos.
Competencia Escrita: Mi mejor amigo/a. Expresar fechas. Traducción ingles a español y Español a Ingles.

Module: 6	**Describir el diario. Las actividades cotidianas.**	**3 hours**
Competencia Gramática: Los Verbos y pronombres reflexivos. Los verbos pronominales con e/ie,o/ue, e/i, u/ue. Competencia Escrita: El horario. Traducción ingles a español y Español a Ingles.		
Module: 7	**Dar opiniones sobre comidas y bebidas. Decir lo que está haciendo. Describir mi ciudad y Ubicar los sitios en la ciudad.**	**4 hours**
Competencia Gramática: Los verbos irregulares. Estar + gerundio. Poder + Infinitivo. Competencia Escrita: Conversación en un restaurante. Traducción ingles a español y Español a Ingles.Mi ciudad natal. Mi Universidad. La clase.Mi fiesta favorita.		
Module: 8	**Guest Lectures / Native Speakers**	**2 hours**
	Total Lecture hours	**30 hours**

Text Book(s)	
1.	Text Book: "Aula Internacional 1", Jaime Corpas, Eva Garcia, Agustin Garmendia, Carmen Soriano Goyal Publication; reprinted Edition, (2010)
Reference Books	
1.	"¡Acción Gramática!" Phil Turk and Mike Zollo, Hodder Murray, London 2006. "Practice makes perfect: Spanish Vocabulary", Dorothy Richmond, McGraw Hill Contemporary, USA, 2012.
2.	"Practice makes perfect: Basic Spanish", Dorothy Richmond, McGraw Hill Contemporary, USA 2009.
3.	"Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España, 2010.

Recommended by Board of Studies	**04-03-2016**		
Approved by Academic Council	**No. 41**	**Date**	**17-06-2016**

Course Code	Course Title	L	T	P	J	C
ESP2001	ESPAÑOL INTERMEDIO	2	0	2	0	3
Pre-requisite		Syllabus version				
		v.1.0				

Course Objectives:

The course gives students the necessary background to:

1. Enable students to read, listen and communicate in Spanish in their day-to-day life.
2. Enable students to describe situations by using present, past and future tenses in Spanish.
3. Enable to develop the comprehension skill in Spanish language.

Expected Course Outcome:

The students will be able to

1. Create sentences in near future and future tenses and correctly using the prepositions like POR and PARA
2. Create sentences in preterito perfecto and correctly use the direct and indirect object pronouns
3. create sentences related to likes and dislikes and also give commands in formal and informal way
4. Create sentences in past tense by using imperfecto and idefinido forms and describe past events
5. Create conversations in Spanish at places like restaurants, hotels, Shops and Railway stations
6. Understand about different Spanish speaking countries and its culture and traditions.

Module:1	Números (101 – 1 millón). Expresar los planesfuturos Los números ordinales.	7 hours

Competencia Gramática: Futuros cercanos (Ir+a+Infinitivo). Futuros (Verbos regulares e irregulares). Uso del POR y PARA.
Competencia Escrita: Traducción ingles a español y español a Ingles.
Comprensión - Los textos y Videos

Module:2	Las ropas, colores y tamaños. Costar, valer,descuentos y rebajas	8 hours

Competencia Gramática: Pronombres objetivos directos e indirectos. El verbo Gustar y Disgustar.
Competencia Escrita: Traducción ingles a español y español a Ingles. Comprensión - Los textos y Videos

Module:3	Escribir un Correo electrónico formal einformal.	7 hours

Competencia Gramática: Imperativos formales e informales. Pretérito perfecto. Competencia Escrita: Traducción ingles a español y español a Ingles.
Comprensión - Los textos y Videos

Module:4	Currículo Vitae. Presentarse en unaentrevista informal.	6 hours

Competencia Gramática: Pretérito imperfecto. Pretérito indefinido.
Competencia Escrita: Traducción ingles a español y español a Ingles.
Comprensión - Los textos y Videos

Module:5	Introducción personal, Expresar losplanes futuros.	5 hours

Comprensión oral: Introducción personal, Expresar los planes futuros. ¿Qué vas a hacer en laspróximas vacaciones? Comprensión auditiva: Las preguntas sobre un cuento auditivo. Relacionar el audio con lasimágenes. Las preguntas basadas en canciones. Medio de transporte: Comprar y Reservar billetes.		
Module:6	**Diálogos entre dos**	**5 hours**
Comprensión oral: Diálogos entre dos (cliente y tendero de ropas, pasajero y empleado, en unrestaurante, Reservación de habitación en un hotel). Presentación en una entrevista. Comprensión auditiva: Las preguntas basadas en canciones. Las preguntas basadas en diálogos.		
Module:7	**Presentación de los países hispánicos.**	**5 hours**
Comprensión oral: Dialogo entre un médico y paciente. Presentación de los países hispánicos. Describir su infancia. Describir vacaciones últimas o las actividades de último fin de semana. Comprensión auditiva: Rellenar los blancos del cuento en pasado. Las preguntas basadas en elcuento. Las preguntas basadas en un anuncio		
Module:8	**Guest Lectures/ Native Speakers**	**2 hours**
Total Lecture hours:		**45 hours**

Text Book(s)

1.	"Aula Internacional 1", Jaime Corpas, Eva Garcia, Agustin Garmendia, Carmen Soriano Goyal Publication; reprinted Edition, Delhi (2010).

Reference Books

1.	"¡AcciónGramática!", Phil Turk and Mike Zollo, Hodder Murray, London 2006.
2.	"Practice makes perfect: Spanish Vocabulary", Dorothy Richmond, McGraw Hill Contemporary, USA, 2012.
3.	"Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España, 2010.
4.	"Practice makes perfect: Basic Spanish", Dorothy Richmond, McGraw Hill Contemporary, USA 2009.

Recommended by Board of Studies	**04-03-2016**		
Approved by Academic Council	**No.41**	**Date**	**17-06-2016**

Course Code	Course Title	L	T	P	J	C
FRE2001	Français Progressif	2	0	1	0	3
Pre-requisite	Français quotidien	Syllabus version				
		v. 1.0				

Course Objectives:

The course gives students the necessary background to:

1. Understand isolated sentences and frequently used expressions in relation to immediate priorityareas (personal or family information, shopping, close environment, work).
2. Communicate in simple and routine tasks requiring only a simple and direct exchange ofinformation on familiar and habitual topics.
3. Enable students to describe with simply means his training, his immediate environment and evoke familiar and habitual subjects, evoke subjects that correspond to immediate needs.

Expected Course Outcome:

The students will be able to :

1. Understand expressions in French.
2. Create senteces by using frequent lexicon related to himself, his family, his close environment (family, shopping, work, school, etc).
3. Understand simple, clear messages on internet, authentic documents.
4. Analyse predictable information in common documents, such as advertisements, flyers, menus, schedules, simple personal letters.
5. Create simple and routine tasks.
6. Create simple and direct exchange of information on familiar activities and topics.

Module:1	Expressions simples	8 hours

La vie quotidiennes - Le verbe pronominal - Le passé composé avec l'auxiliaire - avoir et être- le passérécent : venir de + infinitif - Le comparatif - Le superlatif - Les mots interrogatifs (les trois formes) Savoir-faire pour: Faire des achats, faire des commandes dans un restaurant, poser des questions.

Module:2	Les activitiés quotidiennes	6 hours

La vie privée et publique (Les achats, Les voyages, les transports-La nourriture, etc.) - Les lieux de la ville -Les mots du savoir-vivre - Les pronoms indéfinis - Les pronoms démonstratifs - Les pronoms complémentsobjets directs/ indirects - La formation du future simple et future proche

Savoir-faire pour: Réserver les billets pour le voyage, réserver les chambres dans un hôtel, S'informer surles lieux de la ville, indiquer la direction à un étranger.

Module:3	Les activités de loisirs	7 hours

Les loisirs (sports/spectacles/activités) - Les moments de la journée, de l'année- La fête indienne et française – Les goûts - L'impératif - La négation de l'impératif-La place du pronom à l'impératif avec un verbe pronominal.

Savoir-faire pour: Parler de ses goûts, raconter les vacances, formuler des phrases plus compliquées, Raconter les souvenirs de l'enfance, parler sur la tradition de son pays natal.

Module:4	**La Francophonie**	**7 hours**
L'espace francophone - Première approche de la société française – La consommation alimentaire – caractériser un objet – décrire une tenue - Le pronom relatif (qui/que/dont/où) Savoir-faire pour : Articles de la presse-Portrait d'une personne-Cartes et messages d'invitation, d'acceptation ou de refus -Article de presse - rédaction d'un événement.		
Module:5	**La culture française**	**5 hours**
Parler de ses activités quotidiennes - les fêtes en France – Parler de sa famille – réserver un billet à l'agence - la gastronomie française		
Module:6	**La description**	**5 hours**
Décrire physiquement une personne – les vacances – les achats – réserver une chambre dans un hôtel – les plus grands français - raconter des évènements passés		
Module:7	**S'exprimer**	**5 hours**
Parler du climat - parcours francophone – placer une commande au restaurant –- la mode - parler de son projet d'avenir.		
Module:8	Guest lecures : Guest lecures/ Native speakers	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Alter Ego 1, Méthode de français, Annie Berthet, Hachette, Paris 2010.
2.	Alter Ego 1, Cahier d'exercices, Annie Berthet, Hachette, Paris 2010.
Reference Books	
1.	CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2010.
2	CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2010
3	Fréquence jeunes-1, Méthode de français, G. Capelle et N. Gidon, Hachette, Paris, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**04-03-2016**		
Approved by Academic Council	**No.41**	**Date**	**17-06-2016**

Course Code	Course Title	L	T	P	J	C
GER1001	GRUNDSTUFE DEUTSCH	2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

The course gives students the necessary background to:

1. Demonstrate Proficiency in reading, writing, and speaking in basic German. Learning vocabulary related to profession, education centres, day-to-day activities, food, culture, sportsand hobby, family set up, workplace, market and classroom activities are essential.
2. Make the students industry oriented and make them adapt in the German culture.

Expected Course Outcome:

The students will be able to

1. Remember greeting people, introducing oneself and understanding basic expressions inGerman.
2. Understand basic grammar skills to use these in a meaning way.
3. Remember beginner's level vocabulary
4. Create sentences in German on a variety of topics with significant precision and in detail.
5. Apply good comprehension of written discourse in areas of special interests.

Module: 1	3 hours

Begrüssung, Landeskunde, Alphabet, Personalpronomen, Verben- heissen, kommen, wohnen, lernen, Zahlen (1-100), W-Fragen, Aussagesätze, Nomen- Singular und Plural, der Artikel -Bestimmter- Unbestimmter Artikel)

Lernziel : Sich vorstellen, Grundlegendes Verständnis von Deutsch, Deutschland in Europa

Module: 2	3 hours

Konjugation der Verben (regelmässig /unregelmässig),das Jahr- Monate, Jahreszeiten und die Woche, Hobbys, Berufe, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit ‚Sie"

Lernziel: Sätze schreiben, über Hobbys, Berufe erzählen, usw

Module: 3	5 hours

Possessivpronomen, Negation, Kasus (Bestimmter- Unbestimmter Artikel) Trennbareverben, Modalverben, Uhrzeit, Präpositionen, Lebensmittel, Getränkeund Essen, Farben, Tiere

Lernziel : Sätze mit Modalverben, Verwendung von Artikel, Adjektiv beim Verb

Module: 4	5 hours

Übersetzung: (Deutsch – Englisch / Englisch – Deutsch)

Lernziel : Die Übung von Grammatik und Wortschatz

Module: 5	5 hours

Leserverständnis. Mindmap machen, Korrespondenz- Briefe und Email

Lernziel: Übung der Sprache, Wortschatzbildung

Module: 6		**3 hours**
Aufsätze : Die Familie, Bundesländer in Deutschland, Ein Fest in Deutschland, **Lernziel :** Aktiver, selbständiger Gebrauch der Sprache		
Module: 7		**4 hours**
Dialoge: a) Gespräche mit einem/einer Freund /Freundin. b) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ; c) in einem Hotel - an der Rezeption ; ein Termin beim Arzt. d) Ein Telefongespräch ; Einladung–Abendessen		
Module: 8		**2 hours**
Guest Lectures / Native Speakers Einleitung in die deustche Kultur und Politik		
Total Lecture hours		**30 hours**

Text Book(s)	
1.	Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, Klett-Langenscheidt Verlag, München : 2013
Reference Books	
1.	Lagune, Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012.
2.	Deutsche Sprachlehre für Ausländer, Heinz Griesbach, Dora Schulz, 2013
3.	Studio d A1, Hermann Funk, Christina Kuhn, CorneslenVerlag, Berlin: 2010
4.	Tangram Aktuell-I, Maria-Rosa, SchoenherrTil, Max Hueber Verlag, Muenchen: 2012
5.	www.goethe.de wirtschaftsdeutsch.dehueber.de klett-sprachen.de www.deutschtraning.org

Mode of Evaluation: CAT / Assignment / Quiz / Seminar / FAT			
Recommended by Board of Studies	**04-03-2016**		
Approved by Academic Council	**No. 41**	**Date**	**17-06-2016**

Course Code	Course Title	L	T	P	J	C
GER2001	Mittelstufe Deutsch	2	0	1	0	3
Pre-requisite	Grundstufe Deutsch	Syllabus version				
		v. 1.0				

Course Objectives:

The course gives students the necessary background to:

1. Improve the communication skills in German language
2. Improve the listening and understanding capability of German FM Radio, and TV Programmes, Films
3. Build the confidence of the usage of German language and better understanding of the culture

Expected Course Outcome:

The students will be able to

1. Create proficiency in advanced grammar and rules
2. Understand the texts including scientific subjects.
3. Create the ability of listening and speaking in real time situations.
4. Create the vocabulary in different context-based situations.
5. Create written communication in profession life, like replying or sending E-mails and letters in a company.
6. Cre#ate communication related to simple and routine tasks.

Module:1	Proficiency in Advanced Grammar	9 hours

Grammatik : Tempus- Perfekt, Präteritum, Plusquamperfekt, Futur-I, Futur-II, Wiederholung der Grundstufen grammatik
Lernziel: Sätzeschreiben in verschiedenen Zeiten.

Module:2	Understanding of Technical Texts	9 hours

Grammatik : Passiv, Personalpronomen (Nominativ, Akkusativ, Dativ)
Lernziel: Passiv, Formen des Personalpronomens

Module:3	Understanding of Scientific texts	9 hours

Adjektivdeklination, Nebensatz, Präpositionen mit Akkusativ und Dativ,Infinitiv Sätze
Lernziel: Verbindung zwischen Adjektiv beim Nomen

Module:4	Communicating in Real Time Situations	8 hours

Übersetzung :Technische Terminologie, wissenschaftliche, literarische Texte aus dem Deutschenins Englische und umgekehrt,
Lernziel : Übung von Grammatik und Wortschatz

Module:5	Acquisition of the Vocabulary of the advanced Level	7 hours

Hörverständnis durch Audioübung : Familie, Leben in Deutschland, Am Bahnhof,
Videos : Politik, Historie, Tagesablauf in eineranderen Stadt,
Lernziel : Übung der Sprache

Module:6	**Ability to Communicate in Professional Life**	**9 hours**
Hörverständnis durch Audioübung: Überberühmte Persönlichkeiten, Feste in Deutschland, Videos :Wetter, An der Universität,ein Zimmer buchen, Studentenleben,Städteund Landeskunde Lernziel : Hörverständnis, Landeskunde		
Module:7	**Ability to Communicate in Task-based Situations**	**7 hours**
Hörverständnis durch Audioübung: FM Radio aus DeutschlanddVideos: Fernseher aus Deutschland Lernziel : LSRW Fähigkeiten		
	Total Lecture hours:	**60 hours**

Text Book(s)

1.	TangramAktuell II, Rosa Maria Dallapizza, Beate Blüggel, Max Hueber Verlag ,München : 2010

Reference Books

1.	ThemenAktuell, Heiko Bock, Mueller Jutta, MaxHueber Verla, Muenchen : 2010
2.	Deutsch Sprachlehre fuer Auslaender, Schulz Griesbach, Max Hueber Verlag, Muenchen : 2012
3.	Lagune, Deutsch als Fremdsprache, Jutta Müller, Storz Thomas, Hueber Verlag, Ismaning : 2013
4.	Studio d A1, Hermann Funk, Christina Kuhn, Max HuerberVerlag, München : 2011

Mode of Evaluation: CAT / Assignment / Quiz / FAT

Recommended by Board of Studies	**04-03-2016**		
Approved by Academic Council	**No.41**	**Date**	**17-06-2016**

Course Code	Course Title	L	T	P	J	C
GRE1001	Modern Greek	2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To master the Greek terminology widely used in their subjects of specialization
2. To communicate in Modern Greek in their day-to-day life
3. To provide general information about Greece (e.g., geography, weather, food etc.)

Expected Course Outcomes:

4. Students will be able:
5. To correctly pronounce Greek symbols and words, being more conscious and confident in the usage of their English vocabulary derived from Greek.
6. To make use of Modern Greek language in simple everyday conversation.
7. To understand contents from scientific texts that make use of Greek symbols and words, becoming familiar with fundamental linguistic aspects of the International Scientific Vocabulary as well as becoming able to formulate hypotheses about unknown compound words derived from Greek.
8. To be more aware about the evolution of Modern European languages, understanding the important connections between English and Greek/Neo-Latin languages.
9. To understand important socio-economic issues in contemporary Europe, developing their aptitude for critical thinking.

Module:1	Greek Alphabet: Correct usage and Pronunciation of Greek symbols	4 hours

Vowels and phonetic rules of diphthongs: alpha-iota / epsilon-iota / omicron-iota / and upsilon / epsilon-upsilon; consonants and their correct pronunciation; double consonants and digraphs.
Grammar skills: correct pronunciation of the 24 Greek letters; correct pronunciation of diphthongs digraphs.

Module:2	Greetings, introducing oneself; Proper Nouns and Proper Greek Names	3 hours

Communicative functions: using formal and informal greetings; introducing oneself using affirmative form.
Grammar skills: nominative case and vocative case (singular), personal pronouns, verbs είμαι (to be) and μελένε (to be called).
Written communication skills: introducing oneself using Greek letters and words.

Module:3	Nationality and Provenance	5 hours

Communicative functions: providing personal details such as nationality, address and telephone number; Being able to name a few relevant landmarks in a city.
Grammar skills: Common nouns (masculine in -ος/-ης/-ας; feminine in -α/-η; neuter in -ο/-ι); από / σε + accusative case; cardinal numerals from 1 to 10; verb μένω (simple present).
Written communication skills: introducing oneself providing specific details about country and city of

origin, address, telephone number.		
Module:4	**Family**	**5 hours**
Communicative functions: describing one's family and describing elementary physical traits (μικρός/μεγάλος – μελαχρινός/ξανθός – ψηλός/κοντός). Grammar skills: possessive pronouns (singular/plural); word accent Written communication skills: describing family and family members.		
Module:5	**In the classroom: introducing others, languages and nationality adjectives**	**4 hours**
Ccommunicative functions: introducing others by providing information on their nationality and spoken language(s); naming the objects in a classroom. Grammar skills: verb μιλώ (simple present); nationality adjectives. Written communication skills: introducing friends and relatives providing specific information about the language they speak.		
Module:6	**Months and seasons of the year; days of the week; time and weather**	**4 hours**
Communicative functions: defining time and date; talking about weather conditions. Grammar skills: cardinal numerals from 11 to 100; interrogative pronoun (ποιος-ποια-ποιο/τι); time adverbials (τώρα, σήμερα, χθες, αύριο, φέτος πέρσι, τουχρόνου, πότε); syntax: υποκείμενο/άμεσο αντικείμενοWritten communication skills: describing weather conditions, defining time and date.		
Module:7	**Daily routine**	**3 hours**
Module content: communicative functions: describing one's daily routine and activities/hobbies. Grammar skills: verbs πάω, ακούω, λέω, τρώω, μπορώ (simple present); plural nouns (nominative case). Written communication skills: writing a simple letter describing a daily routine.		
Module:8	**Contemporary issues:**	**2 hours**
Social and Economic aspects of the 2009-2017 Greek government-debt crisis and of the 2015-2018 European Refugee Crisis.		
	Total Lecture hours:	**30 hours**

Text Book(s):

1.	Maria Karakirgiou, V. Panagiotidou, Jay Schwartz, Kliksta Ellinika (A1), Center for the Greek Language Publishing, Thessaloniki & Athens, 2014.

Reference Book(s):

1.	Maria Kaliambou (Yale University, USA), The Routledge Modern Greek Reader, Routledge 2015.
2.	E. Georgantzi, E. Raftopoulou, Greek for You (Greek – English bilingual edition), Neohel, Athens, 2016.

Recommended by Board of Studies	**31-10-2018**		
Approved by Academic Council	**No. 53**	**Date**	**13-12-2018**

Course Code	Course Title	L	T	P	J	C
JAP1001	JAPANESE FOR BEGINNERS	2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

The course gives students the necessary background to:

1. Develop four basic skills related to reading, listening, speaking and writing Japanese language.
2. Instill in learners an interest in Japanese language by teaching them culture and generaletiquettes.
3. Recognize, read and write Hiragana and Katakana.

Expected Course Outcomes:

Students will be able to:

1. Remember Japanese alphabets and greet in Japanese.
2. Understand pronouns, verbs form, adjectives and conjunctions in Japanese.
3. Remember time and dates related vocabularies and express them in Japanese.
4. Create simple questions and its answers in Japanese.
5. Understand the Japanese culture and etiquettes.

Module: 1	Introduction to Japanese syllables and Greetings	4 hours

Introduction of Japanese language, alphabets; Hiragana, katakana, and Kanji Pronunciation, vowels and consonants. Hiragana – writing and reading; Vocabulary: 50 Nouns and 20 pronouns, Greetings.

Module: 2	Demonstrative Pronouns	4 hours

Grammar: N1 wa N2 desu, Japanese Numerals, Demonstrative pronoun - Kore, Sore, Are and Dore (This, That, Over there, which) Kono, sono, Ano and Dono (this, that, over there, which) Kochira, Sochira, Achira and Dochira. this way) Koko, Soko, Asoko and Doko (Here, There…. location)

Module: 3	Verbs and Sentence formation	4 hours

Classification of verbs Be verb desu Present and Present negative Basic structure of sentence (Subject+ Object + Verb) Katakana-reading and writing

Module: 4	Conjunction and Adjectives	4 hours

Conjunction-Ya…..nado Classification of Adjectives 'I' and 'na'-ending Set phrase – Onegaishimasu – Sumimasen, wakarimasen Particle –Wa, Particle-Ni 'Ga imasu' and 'Ga arimasu' for Existence of living things and non-living things Particle- Ka, Ni, Ga

Module: 5	Vocabulary and its Meaning	4 hours

Days/ Months /Year/Week (Current, Previous, Next, Next to Next) ; Nation, People and Language Relationship of family (look and learn); Simple kanji recognition

Module: 6	**Forming questions and giving answers**	**4 hours**
Classification of Question words (Dare, Nani, Itsu, Doyatte, dooshite, Ikutsu, Ikura); Classification of Te forms, Polite form of verbs		
Module: 7	**Expressing time, position and directions**	**4 hours**
Classification of question words (Doko, Dore, Dono, Dochira); Time expressions (Jikan), Number of hours, Number of months, calendar of a month; Visit the departmental store, railway stations, Hospital (Byoki), office and University		
Module: 8	**Guest Lecture by Experts**	**2 hours**
Total Lecture hours		**30 hours**

Text Book(s):	
1.	The Japan Foundation (2017), Marugoto Japanese Language and Culture Starter A1 Coursebook For Communicative Language Competences, New Delhi: Goyal Publishers (9788183078047)
2.	Banno, Eri et al (2011), Genki: An Integrated Course in Elementary Japanese I [Second Edition], Japan: The Japan Times.
Reference Book(s):	
1.	Japanese for Busy people (2011) video CD, AJALT, Japan.
2.	Carol and Nobuo Akiyama (2010), The Fast and Fun Way, New Delhi: Barron's Publication

Mode of Evaluation: CAT, Quiz and Digital Assignments			
Recommended by Board of Studies	**24-10-2018**		
Approved by Academic Council	**No. 53**	**Date**	**13-12-2018**

Course Code	Course Title	L	T	P	J	C
RUS1001	Russian for Beginners	2	0	0	0	2
Pre- requisites	NIL	Syllabus version				
		v. 1.0				

Course Objective:

1. To enable the students to read and communicate in Russian in their day-to-day life to become industry-ready

Expected Outcome:

1. The students will be able to read and communicate the basics of Russian language in their day-to-day life.

Module 1	Topics	3 hours

Greetings and introductions in Russian; Russian alphabet, writing and reading the Cyrillic alphabet.
The Students learn to: Greet each other in Russian (formal vs. informal; depending of the time of the day). Introduce someone in Russian. Read and write Cyrillic alphabet

Module 2	Topics	3 hours

Basic phrases (yes/no, gratitude, apologies, saying hello/goodbye, etc.); Numbers (1-100); Days of the week, Months of the year; Seasons. Gender of nouns, hard and soft stems, and exceptions. The Students learn to: Have a simple conversation. Know numbers, days of the week, months and seasons.

Module 3	Topics	6 hours

Family (family members and pets). Learn Russian names: last name, first name, and patronymic. House and apartment. Parts of the body and health. Personal pronouns; ты vs. вы. Asking Whose in Russian? The Possessive pronouns. Asking What and Who in Russian? Nominative case. Asking Where? Prepositional case. The Country and Nationality. Prepositions (in/at/on/with etc.). The adjectives (colors, age, appearance, etc.). The Students learn to: Ask questions and demonstrate basic ability to communicate in Russian.

Module 4	Topics	4 hours

Shopping. Food. Clothes. Demonstrative pronouns этот and тот. Dative case of personal pronouns, impersonal constructions. Simple translation (Russian-English-Russian). The Students learn to: Do shopping. Understand a short text in Russian.

Module 5	Topics	5 hours

Travelling. At the airport. Public transportation. Directions. Weather. Form a sentence with the given word. Place the sentences into plural form. Formulate questions. The Students learn to: Formulate and answer general questions in Russian. Express sentences given in Male or Female, Ask about and find a destination.

Module 6	**Topics**	**3 hours**
Studying and Teaching. Profession. About myself. The Students learn to: Be able to tell about themselves (family, university, house, leisure, etc.)		
Module 7	**Topics**	**4 hours**
Dialogues: a) At the airport. b) In a cafeteria, grocery store, farmer's market, etc. About family - Between friends.		
Module 8	**Guest Lectures / native speakers**	**2 hours**
	Total Lecture Hours	**30**

Mode of Evaluation: CAT, Quiz and Digital Assignments			
Recommended by Board of Studies	**04-03-2016**		
Approved by Academic Council:	**No.:41**	**Date:**	**17-06-2016**

NON-CREDIT COURSES

(2019 - 2020)

B. Tech. Computer Science and Engineering and Business Systems

(in collaboration with TCS)

Course Code	Course Title	L	T	P	J	C
CHY1002	Environmental Sciences	3	0	0	0	3
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
		v. 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 in dividuals 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 perspective
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.

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:** Lecture by Industry Experts	**2 hours**
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**

Course code	Course title	L	T	P	J	C
ENG1000	Foundation English - I	0	0	4	0	2
Pre-requisite	Less than 50% EPT score	Syllabus Version				
		v. 1.0				

Course Objectives:

1. To equip learners with English grammar and its application.
2. To enable learners to comprehend simple text and train them to speak and write flawlessly.
3. To familiarize learners with MTI and ways to overcome them.

Expected Course Outcome:

1. Develop the skills to communicate clearly through effective grammar, pronunciation and writing.
2. Understand everyday conversations in English
3. Communicate and respond to simple questions about oneself.
4. Improve vocabulary and expressions.
5. Prevent MTI (Mother Tongue Influence) during usual conversation.

Module:1	**Essentials of grammar**	**3 Hours**
Understand basic grammar-Parts of Speech Activity: Grammar worksheets on parts of speech		
Module:2	**Vocabulary Building**	**3 Hours**
Vocabulary development; One word substitution Activity: Elementary vocabulary exercises		
Module:3	**Applied grammar and usage**	**4 Hours**
Types of sentences; Tenses Activity: Grammar worksheets on types of sentences; tenses		
Module:4	**Rectifying common errors in everyday conversation**	**4 Hours**
Detect and rectify common mistakes in everyday conversation Activity: Common errors in prepositions, tenses, punctuation, spelling and other parts of speech; Colloquialism		
Module :5	**Jumbled sentences**	**2 Hours**
Sentence structure; Jumbled words to form sentences; Jumbled sentences to form paragraph/ short story Activity: Unscramble a paragraph / short story		
Module:6	**Text-based Analysis**	**4 Hours**
Wings of Fire -Autobiography of APJ Abdul Kalam (Excerpts) Activity: Enrich vocabulary by reading and analyzing the text		

Module:7	**Correspondence**	**3 Hours**
Letter, Email, Application Writing Activity: Compose letters; Emails, Leave applications		
Module:8	**Listening for Understanding**	**4 Hours**
Listening to simple conversations & gap fill exercises Activity: Simple conversations in Received Pronunciation using audio-visual materials.		
Module:9	**Speaking to Convey**	**6 Hours**
Self-introduction; role-plays; Everyday conversations Activity**:** Identify and communicate characteristic attitudes, values, and talents; Working and interacting within groups		
Module:10	**Reading for developing pronunciation**	**6 Hours**
Loud reading with focus on pronunciation by watching relevant video materials Activity: Practice pronunciation by reading aloud simple texts; Detecting syllables; Visually connecting to the words shown in relevant videos		
Module:11	**Reading to Contemplate**	**4 Hours**
Reading short stories and passages Activity: Reading and analyzing the author's point of view; Identifying the central idea.		
Module:12	**Writing to Communicate**	**6 Hours**
Paragraph Writing; Essay Writing; Short Story Writing Activity: Writing paragraphs, essays and short- stories		
Module:13	**Interpreting Graphical Data**	**6 Hours**
Describing graphical illustrations; interpreting basic charts, tables, and formats Activity: Interpreting and presenting simple graphical representations/charts in the form of PPTs		
Module:14	**Overcoming Mother Tongue Influence (MTI) in Pronunciation**	**5 Hours**
Practicing common variants in pronunciation Activity: Identifying and overcoming mother tongue influence.		
	Total Laboratory Hours	**60 Hours**

Text Book / Workbook	
1.	Wren, P.C., & Martin, H. (2018).High School English Grammar & Composition N.D.V. PrasadaRao (Ed.). NewDelhi: S. Chand & Company Ltd.
2.	McCarthy, M. O'Dell, F.,& Bunting, J.D. (2010).Vocabulary in Use(High Intermediate students book with answers). Cambridge University Press
Reference Books	
1.	Watkins, P.(2018).Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers. Cambridge University Press.
2.	Mishra, S., &Muralikrishna, C. (2014).Communication Skills for Engineers. Pearson Education

	India
3	Lewis, N. (2011).Word Power Made Easy. Goyal Publisher
4	https:/americanliterature.com/short-short-stories
5	Tiwari, A., &Kalam, A. (1999).Wings of Fire - An Autobiography of Abdul Kalam. Universities Press (India) Private Limited.

Mode of Evaluation: Quizzes, Presentation, Discussion, Role Play, Assignments

List of Challenging Experiments (Indicative)		
1.	Rearranging scrambled sentences	**8 hours**
2.	Identifying errors in oral and written communication	**12 hours**
3.	Critically analyzing the text	**8 hours**
4.	Developing passages from hint words	**8 hours**
5.	Role-plays	**12 hours**
6.	Listening to a short story and analyzing it	**12 hours**
	Total Laboratory Hours	**60 hours**

Mode of Evaluation: Quizzes, Presentation, Discussion, Role Play, Assignments

Recommended by Board of Studies	**08-06-2019**		
Approved by Academic Council	**No. 55**	**Date**	**13-06-2019**

Course code	Course title	L	T	P	J	C
ENG2000	Foundation English - II	0	0	4	0	2
Pre-requisite	51% - 70% EPT Score / Foundation English I	Syllabus version				
		v.1.0				

Course Objectives:

1. To practice grammar and vocabulary effectively
2. To acquire proficiency levels in LSRW skills in diverse social situations.
3. To analyze information and converse effectively in technical communication.

Expected Course Outcome:

1. Accomplish a deliberate reading and writing process with proper grammar and vocabulary.
2. Comprehend sentence structures while Listening and Reading.
3. Communicate effectively and share ideas in formal and informal situations.
4. Understand specialized articles and technical instructions and write clear technical correspondence.
5. Critically think and analyze with verbal ability.

Module:1	Grammatical Aspects	4 hours

Sentence Pattern, Modal Verbs, Concord (SVA), Conditionals, Connectives
Activity : Worksheets, Exercises

Module:2	Vocabulary Enrichment	4 hours

Active & Passive Vocabulary, Prefix and Suffix, High Frequency Words
Activity : Worksheets, Exercises

Module:3	Phonics in English	4 Hours

Speech Sounds – Vowels and Consonants – Minimal Pairs- Consonant Clusters- Past Tense Marker and Plural Marker
Activity : Worksheets, Exercises

Module:4	Syntactic and Semantic Errors	2 Hours

Tenses /SVA/Articles/ Prepositions/ Punctuation & Right Choice of Vocabulary
Activity : Worksheets, Exercises

Module:5	Stylistic errors	2 Hours

Dangling Modifiers, Parallelism, Standard English, Ambiguity, Redundancy, Brevity
Activity : Worksheets, Exercises

Module:6	Listening and Note making	6 Hours

Intensive and Extensive Listening - Scenes from plays of Shakespeare (Eg: Court scene in *The Merchant of Venice*, Disguise Scene in *The Twelfth Night*, Death of Desdemona in *Othello*, Death scene in *Julius Caesar* and Balcony scene from *Romeo and Juliet*)
Activity : Summarizing; Note-making and drawing inferences from Short videos

Module:7	**Art of Public Speaking**	**6 Hours**
Impromptu, Importance of Non-verbal Communication, Technical Talks, Dynamics of Professional Presentations – Individual & Group Activity : Ice Breaking; Extempore speech; Structured technical talk and Group presentation		
Module:8	**Reading Comprehension Skills**	**4 Hours**
Skimming, scanning, comprehensive reading, guessing words from context, understanding text organization, recognizing argument and counter-argument; distinguishing between main information and supporting detail, fact and opinion, hypothesis versus evidence; summarizing and note-taking, Critical Reasoning Questions – Reading and Discussion Activity: Reading of Newspapers Articles and Worksheets on Critical Reasoning from web resources		
Module: 9	**Creative Writing**	**4 Hours**
Structure of an essay, Developing ideas on analytical/ abstract topics Activity: Movie Review, Essay Writing on suggested Topics, Picture Descriptions		
Module: 10	**Verbal Aptitude**	**6 hours**
Word Analogy, Sentence Completion using Appropriate words, Sentence Correction Activity: Practicing the use of appropriate words and sentences through web tools.		
Module: 11	**Business Correspondence**	**4 hours**
Formal Letters- Format and purpose: Business Letters - Sales and complaint letter Activity: Letter writing- request for Internship, Industrial Visit and Recommendation		
Module: 12	**Career Development**	**6 hours**
Telephone Etiquette, Resume Preparation, Video Profile Activity: Preparation of Video Profile		
Module: 13	**Art of Technical Writing - I**	**4 hours**
Technical Instructions, Process and Functional Description Activity: Writing Technical Instructions		
Module: 14	**Art of Technical Writing – II**	**4 hours**
Format of a Report and Proposal Activity: Technical Report Writing, Technical Proposal		
	Total Lecture hours:	**60 hours**

Text Book / Workbook

1.	Sanjay Kumar & Pushp Lata, Communication Skills, 2nd Edition, OUP, 2015
2	Wren & Martin, High School English Grammar & Composition, Regular ed., ND: Blackie ELT Books, 2018

Reference Books	
1	Peter Watkins, Teaching and Developing Reading Skills: Cambridge Handbooks for Language Teachers, Cambridge, 2018
2	Aruna Koneru, Professional Speaking Skills, OUP, 2015.
3	J.C.Nesfield, English Grammar English Grammar Composition and Usage, Macmillan. 2019.
4	Richard Johnson-Sheehan, Technical Communication Today, 6th edition, ND: Pearson, 2017.
5	Balasubramaniam, Textbook of English Phonetics For Indian Students, 3rd Edition , S. Chand Publishers, 2013.

Web Resources

1. https://www.hitbullseye.com/Sentence-Correction-Practice.php
2. https://hitbullseye.com/Critical-Reasoning-Practice-Questions.php

Mode of Evaluation: Presentation, Discussion, Role Play, Assignments , FAT

List of Challenging Experiments (Indicative)		
1.	Reading and Analyzing Critical Reasoning questions	8 hours
2.	Listening and Interpretation of Videos	12 hours
3.	Letter to the Editor	6 hours
4.	Developing structured Technical Talk	12 hours
5.	Drafting SOP (Statement of Purpose)	10 hours
6.	Video Profile	12 hours
	Total Laboratory Hours	**60 hours**

Mode of Evaluation: Presentation, Discussion, Role Play, Assignments, FAT

Recommended by Board of Studies	**08-06-2019**		
Approved by Academic Council	**No. 55**	**Date**	**13-06-2019**