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

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

B. Tech Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

Curriculum and Syllabus
(*2020-2021 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF COMPUTER SCIENCE & 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 & ENGINEERING

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

B. Tech Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.

3. Graduates will function in their profession with social awareness and responsibility.

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.

5. Graduates will be successful in pursuing higher studies in engineering or management.

6. Graduates will pursue career paths in teaching or research.

B. Tech Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

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 analyse 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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Analyze, design, develop and test mathematical foundations in the development of computational solutions of both computer software and hardware.

PSO2: Demonstrate the knowledge about the application of AI technologies and methodologies for robots to adapt to challenging environments.

PSO3: Develop skills to approach and solve social issues with AI enabled robots to ensure standards and ethics.

B. Tech Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University Core (UC)	**53**
Programme Core (PC)	**63**
University Elective (UE)	**12**
Programme Elective (PE)	**32**
Total	**160**

B. Tech Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

DETAILED CURRICULUM

University Core

Sl. No	Course Code	Course Title	L	T	P	J	C	Pre- Requisite
1	ENG1901	Technical English- I	0	0	4	0	2	Foundation English II
2	ENG1902	Technical English- II	0	0	4	0	2	71% to 90% in EPT
3	ENG1903	Advanced Technical English	0	0	2	4	2	Greater than 90% score in EPT
4	CHY1701	Engineering Chemistry	3	0	2	0	4	
5	PHY1701	Engineering Physics	3	0	2	0	4	-
6	MAT1011	Calculus for Engineers	3	0	2	0	4	10+2 Mathematics or MAT1001
7	MAT2001	Statistics for Engineers	3	0	2	0	4	MAT1011
8	FLC4097	Foreign Language	2	0	0	0	2	-
9	HUM1021	Ethics and Values	2	0	0	0	2	-
10	CSE1001	Problem Solving and Programming	0	0	6	0	3	-
11	CSE1002	Problem Solving and Object Oriented Programming	0	0	6	0	3	-
12	MGT1022	Lean Startup Management	1	0	0	4	2	-
13	CSE1901	Technical Answers for Real Word Problems (TARP)	1	0	0	4	2	PHY1901 and 115 credits earned
14	CSE1902	Industrial Internship					1	Completion of minimum 2 semester
15	CSE1904	Capstone Project					12	As per academic regulations
16	CSE1903	Comprehensive Examination	0	0	0	0	1	-
17		Soft Skills *					6	-
18	CHY1002	Environmental Sciences	3	0	0	0	0	-
19	PHY1901	Introduction to Innovative Projects	1	0	0	0	1	-
20	EXC	Co / Extracurricular Activity	0	0	0	0	0	-

B. Tech Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

Programme Core

Sl.No	Course Code	Course Title	L	T	P	J	C	Pre-Requisite	Categaory
1.	MAT1014	Discrete Mathematics and Graph Theory	3	1	0	0	4		S
2.	CSE1003	Digital Logic and Design	3	0	2	0	4	-	E
3.	CSE2001	Computer Architecture and Organization	3	0	0	0	3	-	E
4.	CSE2011	Data Structures and algorithms	3	0	2	0	4	-	E
5.	CSE2012	Design and Analysis of Algorithms	3	0	2	0	4	CSE2011	E
6.	CSE1004	Network and Communication	3	0	2	0	4	-	E
7.	CSE2004	Database Management System	2	0	2	4	4	-	E
8.	CSE2005	Operating Systems	3	0	2	0	4	-	E
9.	CSE2006	Microprocessor and Interfacing	2	0	2	4	4	-	E
10.	CSE1007	JAVA Programming	3	0	2	0	4	-	E
11.	MAT2010	Mathematical Methods for Computer Vision, Robotics, and Graphics	2	0	2	0	3	MAT1011	E
12.	ECE2035	Sensors, Actuators and Signal Conditioning	2	0	2	4	4	-	E
13.	CSE1022	Foundations of Robotics: kinematics, Dynamics and motion control	2	0	2	4	4	-	E
14.	CSE3102	Simulation and Modeling	2	0	2	0	3	-	E
15.	ECE2036	Signal Processing in Robotics	3	0	0	0	3	-	E
16.	CSE2038	Fundamentals of Autonomous Systems	3	0	0	0	3	-	E
17.	CSE2039	Fundamentals of Artificial Intelligence	2	0	2	4	4	-	E

B. Tech Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

Programme Elective

S. No.	Course Code	Course Title	L	T	P	J	C	Pre-Requisite
1.	CSE4082	Robot vision	2	0	2	4	4	
2.	CSE3101	Robots, bots and communication	2	0	2	4	4	CSE1004 CSE1022
3.	CSE4083	Humanoid Robotics	2	0	2	0	3	CSE2038
4.	CSE3115	Robot Programming	2	0	2	4	4	CSE3102
5.	CSE4084	Nano and Neuro-robotics	3	0	0	0	3	
6.	CSE2040	Drone Applications, Components and Assembly	3	0	2	0	4	CSE2038
7.	CSE3059	Drones and Autonomous Systems	3	0	2	0	4	CSE2040
8.	CSE3114	Human-Robot Interaction	3	0	0	0	3	
9.	CSE3116	Speech and Language Processing	3	0	0	4	4	
10.	CSE4085	Medical Robotics	3	0	0	0	3	CSE4082
11.	CSE3060	Robotics Based Industrial Automation	3	0	0	0	3	
12.	CSE3117	Internet of Things	2	0	2	4	4	
13.	CSE3118	Cyber Physical Systems	2	0	2	0	3	
14.	CSE4086	Machine Diagnostics and Condition Monitoring	3	0	0	0	3	
15.	CSE3119	Robotic Process Automation	2	0	2	4	4	
16.	CSE4087	Advanced RPA developer	2	0	2	4	4	CSE3119
17.	CSE3105	Machine Learning and its Applications	2	0	2	4	4	
18.	CSE3056	Knowledge Representation and reasoning	2	0	0	4	3	
19.	CSE3057	Reinforcement Learning	2	0	0	4	3	
20.	CSE4088	Deep Learning: Principles and Practices	2	0	2	0	3	
21.	CSE3058	Cognitive Robotics	2	0	2	4	4	
22.	CSE3106	Soft computing	3	0	0	4	4	
23.	CSE3111	Cyber Security	3	0	0	0	3	
24.	CSE3001	Software Engineering Principles	2	0	2	4	4	
25.	CSE3020	Data Visualization	2	0	2	4	4	
26.	CSE3107	Digital Twin	3	0	0	4	4	
27.	CSE3108	Blockchain Technology	2	0	2	0	3	
28.	CSE3109	Cloud computing	2	0	2	4	4	
29.	CSE3110	Edge Computing	2	0	2	4	4	
30.	CSE3505	Foundations of Data Analytics	2	0	2	4	4	
31.	CSE3506	Essentials of Data Analytics	2	0	2	4	4	
32.	CSE3501	Information Security Analysis and Audit	2	0	2	4	4	
33.	CSE3502	Information Security Management	2	0	2	4	4	
34.	ECE3501	IoT Fundamentals	2	0	2	4	4	
35.	ECE3502	IoT Domain Analyst	2	0	2	4	4	

CSE1003	DIGITAL LOGIC AND DESIGN	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**NIL**	**Syllabus version**				
		v1.0				

Course Objectives:

1. Introduce the concept of digital and binary systems.
2. Analyze and Design combinational and sequential logic circuits.
3. Reinforce theory and techniques taught in the classroom through experiments in the laboratory.

Expected Course Outcome:

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

Module:1	**INTRODUCTION**	**3 hours**
Number System - Base Conversion - Binary Codes - Complements(Binary and Decimal)		
Module:2	**BOOLEAN ALGEBRA**	**8 hours**
Boolean algebra - Properties of Boolean algebra - Boolean functions - Canonical and Standard forms - Logic gates - Universal gates – Karnaugh map - Don‟t care conditions - Tabulation Method		
Module:3	**COMBINATIONAL CIRCUIT - I**	**4 hours**
Adder - Subtractor - Code Converter - Analyzing a Combinational Circuit		
Module:4	**COMBINATIONAL CIRCUIT –II**	**6 hours**
Binary Parallel Adder- Look ahead carry - Magnitude Comparator - Decoders – Encoders - Multiplexers –Demultiplexers.		
Module:5	**SEQUENTIAL CIRCUITS – I**	**6 hours**
Flip Flops - Sequential Circuit: Design and Analysis - Finite State Machine: Moore and Mealy model - Sequence Detector.		
Module:6	**SEQUENTIAL CIRCUITS – II**	**7 hours**
Registers - Shift Registers - Counters - Ripple and Synchronous Counters - Modulo counters - Ring and Johnson counters		
Module:7	**ARITHMETIC LOGIC UNIT**	**9 hours**
Bus Organization - ALU - Design of ALU - Status Register - Design of Shifter - Processor Unit - Design of specific Arithmetic Circuits Accumulator - Design of Accumulator.		
Module:8	**Contemporary Issues: RECENT TRENDS**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. M. Morris Mano and Michael D.Ciletti– Digital Design: With an introduction to Verilog HDL, Pearson Education – 5th Edition- 2014. ISBN:9789332535763.

Reference Books

1. Peterson, L.L. and Davie, B.S., 2007. Computer networks: a systems approach. Elsevier.

2.	Thomas L Floyd. 2015. Digital Fundamentals. Pearson Education. ISBN: 9780132737968	
3.	Malvino, A.P. and Leach, D.P. and Goutam Saha. 2014. Digital Principles and Applications (SIE). Tata McGraw Hill. ISBN: 9789339203405.	
4.	Morris Mano, M. and Michael D.Ciletti. 2014. Digital Design: With an introduction to Verilog HDL. Pearson Education. ISBN:9789332535763	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	Realization of Logic gates using discrete components, verication of truth table for logic gates, realization of basic gates using NAND and NOR gates	4.5 hours
	Implementation of Logic Circuits by verification of Boolean laws and verification of De Morgans law	3 hours
	Adder and Subtractor circuit realization by implementation of Half-Adder and Full-Adder, and by implementation of Half-Subtractor and Full-Subtractor	4.5 hours
	Combinational circuit design i. Design of Decoder and Encoder ii. Design of Multiplexer and De multiplexer iii. Design of Magnitude Comparator iv. Design of Code Converter	4.5 hours
	Sequential circuit design i. Design of Mealy and Moore circuit ii. Implementation of Shift registers iii. Design of 4-bit Counter iv. Design of Ring Counter	4.5 hours
	Implementation of different circuits to solve real world problems: A digitally controlled locker works based on a control switch and two keys which are entered by the user. Each key has a 2-bit binary representation. If the control switch is pressed, the locking system will pass the difference of two keys into the controller unit. Otherwise, the locking system will pass the sum of the two numbers to the controller unit. Design a circuit to determine the input to the controller unit.	4.5 hours
	Implementation of different circuits to solve real world problems: A bank queuing system has a capacity of 5 customers which serves on first come first served basis. A display unit is used to display the number of customers waiting in the queue. Whenever a customer leaves the queue, the count is reduced by one and the count is increased by one if a customer joins a queue. Two sensors (control signals) are used to sense customers leaving and joining the queue respectively. Design a circuit that displays the number of customers waiting in the queue in binary format using LEDs. Binary 1 is represented by LED glow and 0 otherwise.	4.5 hours
	Total Laboratory Hours	**30 hours**

CSE1004	NETWORK AND COMMUNICATION	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**NIL**	**Syllabus version**				
		v1.0				

Course Objectives:

1. To build an understanding among students about the fundamental concepts of computer networking, protocols, architectures, and applications.
2. To help students to acquire knowledge in design, implement and analyze performance of OSI and TCP-IP based Architectures.
3. To implement new ideas in Networking through assignments.

Expected Course Outcome:

1. Interpret the different building blocks of Communication network and its architecture.
2. Contrast different types of switching networks and analyze the performance of network
3. Identify and analyze error and flow control mechanisms in data link layer
4. Design subnetting and analyze the performance of network layer
5. Construct and examine various routing protocols
6. Compare various congestion control mechanisms and identify appropriate Transport layer protocol for real time applications
7. Identify the suitable Application layer protocols for specific applications and its respective security mechanisms

Module:1	**Networking Principles and layered architecture**	**6 hours**

Data Communications and Networking: A Communications Model – Data Communications - Evolution of network, Requirements , Applications, Network Topology (Line configuration, Data Flow), Protocols and Standards, Network
Models (OSI, TCP/IP)

Module:2	**Circuit and Packet switching**	**7 hours**

Switched Communications Networks – Circuit Switching – Packet Switching – Comparison of Circuit Switching and Packet Switching – Implementing Network Software, Networking Parameters(Transmission Impairment, Data Rate and Performance)

Module:3	**Data Link Layer**	**10 hours**

Error Detection and Correction – Hamming Code , CRC, Checksum- Flow control mechanism – Sliding Window Protocol - GoBack - N - Selective Repeat - Multiple access Aloha - Slotted Aloha - CSMA, CSMA/CD – Multiple Access Networks (IEEE 802.3), Token Ring(IEEE 802.5) and Wireless Networks (IEEE 802.11, 802.15)

Module:4	**Network Layer**	**6 hours**

IPV4 Address Space – Notations – Classful Addressing – Classless Addressing – Network Address Translation – IPv6 Address Structure – IPv4 and IPv6 header format.

Module:5	**Routing Protocols**	**4 hours**

Routing-Link State and Distance Vector Routing Protocols- Implementation-Performance Analysis- Packet Tracer.

Module:6	**Transport Layer**	**7 hours**

TCP and UDP-Congestion Control-Effects of Congestion-Traffic Management-TCP Congestion Control-Congestion Avoidance Mechanisms-Queuing Mechanisms-QoS Parameters

Module:7	**Application Layer**	**3 hours**

Application layer-Domain Name System-Case Study : FTP-HTTP-SMTP-SNMP

Module:8	**Recent Trends in Network Security**	**2 hours**

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Computer Networks: A Systems Approach, Larry Peterson and Bruce Davie, 5th Ed, The Morgan Kaufmann Series, Elsevier, 2011.	
2.	Computer Networking: A Top-Down Approach Featuring the Internet, J.F. Kurose and K.W.Ross, 6th Ed., Pearson Education, 2012.	
Reference Books		
1.	Data Communications and Networking, Behrouz A. Forouzan, McGraw Hill Education, 5th Ed., 2012.	
2.	TCP/IP Protocol Suite, Behrouz A. Forouzan, McGraw-Hill Education, 4 Ed., 2009.	
3.	Data and Computer Communications, William Stallings, Pearson Education, 10th Ed, 2013.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1	Demo session of all networking hardware and Functionalities	3 Hours
2	Network configuration commands using Linux	3 Hours
3	Error detection and correction mechanisms	3 Hours
4	Flow control mechanisms	3 Hours
5	IP addressing Classless addressing	3 Hours
6	Observing Packets across the network and Performance Analysis of Routing protocols	3 Hours
7	Socket programming(TCP and UDP) Multi client chatting	3 Hours
8	Simulation of unicast routing protocols	3 Hours
9	Simulation of Transport layer Protocols and analysis of congestion control techniques in network	3 Hours
10	Develop a DNS client server to resolve the given host name or IP address	3 Hours
	Total Laboratory Hours	30 hours

CSE2001	COMPUTER ARCHITECTURE AND ORGANIZATION	L	T	P	J	C
		3	0	0	0	3
Pre-requisite		**Syllabus version**				
		v1.0				

Course Objectives:

1. To acquaint students with the basic concepts of fundamental component, architecture, register organization and performance metrics of a computer.
2. To impart the knowledge of data representation in binary and understand implementation of arithmetic algorithms in a typical computer.
3. To teach students how to describe machine capabilities and design an effective data path design for instruction execution. To introduce students to syntax and semantics ofmachine level programming.
4. To make students understand the importance of memory systems, IO interfacing techniques and external storage and their performance metrics for a typical computer. And explore various alternate techniques for improving the performance of a processor.

Expected Course Outcome:

1. Differentiate Von Neumann, Harvard, and CISC and RISC architectures. Analyze the performance of machines with different capabilities.
2. Illustrate binary format for numerical and characters. Validate efficient algorithmfor arithmetic operations.
3. Construct machine level program for given expression on n-address machine. Analyze and calculate memory traffic for a program execution. Design an efficient data path for an instruction format for a given architecture.
4. Explain the importance of hierarchical memory organization. Able to construct larger memories. Analyze and suggest efficient cache mapping technique and replacement algorithms for given design requirements. Demonstrate hamming code for errordetection and correction.
5. Understand the need for an interface. Compare and contrast memory mapping and IO mapping techniques. Describe and Differentiate different modes of data transfer. Appraise the synchronous and asynchronous bus for performance and arbitration.
6. Understand the structure and read write mechanisms for different storage systems. Illustrate and suggest appropriate use of RAID levels. Assess the performance of IO and external storage systems.
7. Classify parallel machine models. Illustrate typical 6-stage pipeline foroverlapped execution. Analyze the hazards and solutions.

Module:1	Introduction and overview of computer architecture	3 hours

Introduction to computer systems - Overview of Organization and Architecture -Functional components of a computer -Registers and register files-Interconnection of components-Organization of the von Neumann machine and Harvard architecture-Performance of processor

Module:2	Data Representation And Computer Arithmetic	6 hours

Fixed point representation of numbers-algorithms for arithmetic operations: multiplication (Booths, Modified Booths) - division (restoring and non-restoring) - Floating point representation with IEEE standards and algorithms for common arithmetic operations- Representation of non-numeric data (character codes).

Module:3	**Fundamentals of Computer Architecture**	**11 hours**
Introduction to ISA (Instruction Set Architecture)-Instruction formats- Instruction types and addressing modes- Instruction execution (Phases of instruction cycle)- Assembly language programming-Subroutine call and return mechanisms-Single cycle Data path design-Introduction to multi cycle data path-Multi cycle Instruction execution.		
Module:4	**Memory System Organization and Architecture**	**9 hours**
Memory systems hierarchy-Main memory organization-Types of Main memory-memory inter-leaving and its characteristics and performance- Cache memories: address mapping-line size-replacement and policies- coherence- Virtual memory systems- TLB- Reliability of memory systems- error detecting and error correcting systems.		
Module:5	**Interfacing and Communication**	**7 hours**
I/O fundamentals: handshaking, buffering-I/O techniques: programmed I/O, interrupt-driven I/O, DMA- Interrupt structures: vectored and prioritized-interrupt overhead- Buses: Syn- chronous and asynchronous- Arbitration.		
Module:6	**Device Subsystems**	**4 hours**
External storage systems-organization and structure of disk drives: Electronic- magnetic and optical technologies- RAID Levels- I/O Performance		
Module:7	**Performance Enhancements**	**4 hours**
Classification of models - Flynns taxonomy of parallel machine models (SISD, SIMD, MISD, MIMD)- Introduction to Pipelining- Pipelined data path-Introduction to hazards		
Module:8	**Contemporary issues: Recent Trends**	**1 hour**
Multiprocessor architecture: Overview of Shared Memory architecture, Distributed architecture.		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	David A. Patterson and John L. Hennessy Computer Organization and Design-The Hardware/Software Interface 5th edition, Morgan Kaufmann, 2013.
2.	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer organization, Mc Graw Hill, Fifth edition, Reprint 2011.
Reference Books	
1.	W. Stallings, Computer organization and architecture, Prentice-Hall, 8th edition, 2013
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

CSE2004	DATABASE MANAGEMENT SYSTEM	L	T	P	J	C
		2	0	2	4	4
Pre-requisite	**NIL**	**Syllabus version**				
		v1.0				

Course Objectives:

1. To understand the concept of DBMS and ER Modeling.
2. To explain the normalization, Query optimization and relational algebra.
3. To apply the concurrency control, recovery, security and indexing for the real time data.

Expected Course Outcome:

1. Explain the basic concept and role of DBMS in an organization.
2. Illustrate the design principles for database design, ER model and normalization.
3. Demonstrate the basics of query evaluation and heuristic query optimizationtechniques.
4. Apply Concurrency control and recovery mechanisms for the desirable database problem.
5. Compare the basic database storage structure and access techniques including B Tree, B+ Tress and hashing.
6. Review the fundamental view on unstructured data and its management.
7. Design and implement the database system with the fundamental concepts of DBMS.

Module:1	**DATABASE SYSTEMS CONCEPTS AND ARCHITECTURE**	**5 hours**

History and motivation for database systems -characteristics of database approach - Actors on the scene - Workers behind the scene - Advantages of using DBMS approach– Data Models, Schemas, and Instances– Three-Schema Architecture and Data Independence– The Database System Environment– Centralized and Client/Server Architectures for DBMSs– Classification of database management systems.

Module:2	**DATA MODELING**	**4 hours**

Entity Relationship Model : Types of Attributes, Relationship, Structural Constraints - Relational Model, Relational model Constraints - Mapping ER model to a relational schema - Integrity constraints

Module:3	**SCHEMA REFINEMENT**	**6 hours**

Guidelines for Relational Schema – Functional dependency; Normalization, Boyce Codd Normal Form, Multi-valued dependency and Fourth Normal form; Join dependency and Fifth Normal form.

Module:4	**QUERY PROCESSING AND TRANSACTION PROCESSING**	**5 hours**

Translating SQL Queries into Relational Algebra - heuristic query optimization - Introduction to Transaction Processing - Transaction and System concepts – Desirable properties of Transactions - Characterizing schedules based on recoverability - Characterizing schedules based on serializability

Module:5	**CONCURRENCY CONTROL AND RECOVERY TECHNIQUES**	**4 hours**

Two-Phase Locking Techniques for Concurrency Control – Concurrency Control based on timestamp – Recovery Concepts – Recovery based on deferred update – Recovery techniques based on immediate update - Shadow Paging.

Module:6	**PHYSICAL DATABASE DESIGN**	**3 hours**
Indexing: Single level indexing, multi-level indexing, dynamic multilevel Indexing		
Module:7	**RECENT TRENDS - NOSQL DATABASE MANAGEMENT**	**3 hours**
Introduction, Need of NoSQL, CAP Theorem, different NoSQL data models: Key-value stores, Column families, Document databases, Graph databases		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	R. Elmasri S. B. Navathe, Fundamentals of Database Systems, Addison Wesley, 2015
2.	Raghu Ramakrishnan,Database Management Systems,Mcgraw-Hill,4th edition,2015.
Reference Books	
1.	A. Silberschatz, H. F. Korth S. Sudershan, Database System Concepts, McGraw Hill, 6th Edition 2010.
2.	Thomas Connolly, Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation and Management,6th Edition,2012.
3.	Pramod J. Sadalage and Marin Fowler, NoSQL Distilled: A brief guide to merging world of Polyglot persistence, Addison Wesley, 2012.
4.	Shashank Tiwari ,Professional NoSql,Wiley ,2011
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	DDL and DML	3 hours
2.	Single row and aggregate functions	3 hours
3.	Joins and Sub queries	3 hours
4.	Anonymous blocks and control structures	3 hours
5.	Iterations	3 hours
6.	Cursors	3 hours
7.	Functions and Procedures	3 hours
8.	Exception Handling and triggers	3 hours
9.	DBA Concepts	3 hours
10.	XML, DTD, XQuery Representations	3 hours
	Total Laboratory Hours	**30 hours**
Mode of assessment: Project/Activity		

Course code	Course Title	L	T	P	J	C
CSE2005	OPERATING SYSTEMS	3	0	2	0	4
Pre-requisite	Nil	Syllabus version				
		v.x.x				

Course Objectives:

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

Expected Course Outcome:

1. Interpret the evolution of OS functionality, structures and layers.
2. Apply various types of system calls and to find the stages of various process states.
3. Design a model scheduling algorithm to compute various scheduling criteria.
4. Apply and analyze communication between inter process and synchronization techniques.
5. Implement page replacement algorithms, memory management problems and segmentation.
6. Differentiate the file systems for applying different allocation and access techniques.
7. Representing virtualization and demonstrating the various Operating system tasks and the principle algorithms for enumerating those tasks.

Module:1	Introduction	3 hours	CO:1

Introduction to OS: Functionality of OS - OS design issues - Structuring methods (monolithic, layered, modular, micro-kernel models) - Abstractions, processes, resources - Influence of security, networking, and multimedia.

Module:2	OS Principles	4 hours	CO:2

System calls, System/Application Call Interface – Protection: User/Kernel modes - Interrupts - Processes - Structures (Process Control Block, Ready List etc.), Process creation, management in Unix – Threads: User level, kernel level threads and thread models.

Module:3	Scheduling	9 hours	CO:3

Processes Scheduling - CPU Scheduling: Pre-emptive, non-pre-emptive - Multiprocessor scheduling – Deadlocks - Resource allocation and management - Deadlock handling mechanisms: prevention, avoidance, detection, recovery.

Module:4	Concurrency	8 hours	CO:4

Inter-process communication, Synchronization - Implementing synchronization primitives (Peterson's solution, Bakery algorithm, synchronization hardware) - Semaphores – Classical

synchronization problems, Monitors: Solution to Dining Philosophers problem – IPC in Unix, Multiprocessors and Locking - Scalable Locks - Lock-free coordination.			
Module:5	**Memory Management**	**7 hours**	**CO:5**
Main memory management, Memory allocation strategies, Virtual memory: Hardware support for virtual memory (caching, TLB) – Paging - Segmentation - Demand Paging - Page Faults - Page Replacement -Thrashing - Working Set.			
Module:6	**Virtualization and File System Management**	**6 hours**	**CO:7**
Virtual Machines - Virtualization (Hardware/Software, Server, Service, Network - Hypervisors - Container virtualization - Cost of virtualization - File system interface (access methods, directory structures) - File system implementation (directory implementation, file allocation methods) - File system recovery - Journaling - Soft updates - Log-structured file system - Distributed file system.			
Module:7	**Storage Management, Protection and Security**	**6 hours**	**CO:6**
Disk structure and attachment – Disk scheduling algorithms (seek time, rotational latency based)- System threats and security – Policy vs mechanism - Access vs authentication - System protection: Access matrix – Capability based systems - OS: performance, scaling, future directions in mobile OS.			
Module:8	**Recent Trends**	**2 hours**	**CO:7**
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	Abraham Silberschatz, Peter B. Galvin, Greg Gagne-Operating System Concepts, Wiley (2018).
Reference Books	
1.	Ramez Elmasri, A.Gil Carrick, David Levine, Operating Systems, A Spiral Approach - McGrawHill Higher Education (2010).
2.	Remzi H. Arpaci-Dusseau, Andrea C. Arpaci-Dusseau, Operating Systems, Three Easy Pieces, Arpaci-Dusseau Books, Inc (2015).
3.	Andrew S. Tanenbaum, Modern Operating Systems, Pearson, 4th Edition (2016).
4.	William Stallings, Operating Systems: Internals and Design Principles, Pearson, 9th Edition (2018).
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
List of Experiments	
1.	Design a boot loader - to load a particular OS say TinyOS/ KolibriOS image - code to access from BIOS to loading the OS - involves little assembly code may use QEMU/virtual machines for emulation of hardware. 3 hours

2.	Allocate/free memory to processes in whole pages, find max allocatable pages, incorporate address translation into the program.	3 hours
3.	Create an interrupt to handle a system call and continue the previously running process after servicing the interrupt.	3 hours
4.	Write a Disk driver for the SATA interface. Take care to check readiness of the controller, locked buffer cache, accept interrupts from OS during the period, interrupting the OS again once done and clearing buffers.	3 hours
5.	Demonstrate the use of locks in conjunction with the IDE driver.	3 hours
6.	Run an experiment to determine the context switch time from one process to another and one kernel thread to another. Compare the findings	3 hours
7.	Determine the latency of individual integer access times in main memory, L1 Cache and L2 Cache. Plot the results in log of memory accessed vs average latency.	3 hours
8.	Compare the overhead of a system call with a procedure call. What is the cost of a minimal system call?	3 hours
9.	Compare the task creation times. Execute a process and kernel thread, determine the time taken to create and run the threads.	3 hours
10.	Determine the file read time for sequential and random access based of varying sizes of the files. Take care not to read from cached data - used the raw device interface. Draw a graph log/log plot of size of file vs average per-block time.	3 hours
	Total Laboratory Hours	30 hours

CSE2006	MICROPROCESSOR AND INTERFACING	L	T	P	J	C
		2	0	2	4	4
Pre-requisite		**Syllabus version**				
		v1.0				

Course Objectives:

1. Students will gain knowledge on architecture, accessing data and instruction from memory for processing.
2. Ability to do programs with instruction set and control the external devices through I/O interface
3. Generate a system model for real world problems with data acquisition, processingand decision making with aid of micro controllers and advanced processors.

Expected Course Outcome:

1. Recall the basics of processor, its ways of addressing data for operation by instruction set.
2. Execute basic and advanced assembly language programs.
3. Learn the ways to interface I/O devices with processor for task sharing.
4. Recall the basics of co-processor and its ways to handle float values by its instruction set.
5. Recognize the functionality of micro controller, latest version processors andits applications.
6. Acquire design thinking capability, abilityto design a component with realistic constraints, to solve real world engineering problems and analyze the results.

Module:1	**INTRODUCTION TO 8086 MICROPROCESSOR**	**6 hours**

Introduction to 8086, Pin diagram, Architecture, addressing mode and Instruction set

Module:2	**INTRODUCTION TO ALP**	**5 hours**

Tools- Assembler Directives, Editor, assembler, debugger, simulator and emulator. E.g., ALP Programs-Arithmetic Operations and Number System Conversions, Programs using Loops, If then else, for loop structures

Module:3	**Advanced ALP**	**2 hours**

Interrupt programming using DOS BIOS function calls, File Management

Module:4	**Introduction to Peripheral Interfacing-I**	**5 hours**

PPI 8255, Timer 8253,Interrupt controller-8259

Module:5	**Introduction to Peripheral Interfacing-II**	**4 hours**

IC 8251 UART, Data converters (A/D and D/A Converter), seven segment display and key- board interfacing

Module:6	**Co-Processor**	**4 hours**

Introduction to 8087, Architecture, Instruction set and ALP Programming

Module:7	**Introduction to Arduino Boards**	**2 hours**

Introduction to Microcontroller- Quark SOC processor, programming, Arduino Boards using GPIO (LED, LCD, Keypad, Motor control and sensor), System design application and case study.

Module:8	**Contemporary issues**		**2 hours**
Architecture of one of the advanced processors such as Multicore, Snapdragon, ARM processor in iPad			
	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	A.K. Ray and K.M. Bhurchandi Advanced Microprocessors and Peripherals, third Edition, Tata McGraw Hill, 2012.
2.	Barry B Bray , The Intel Microprocessor 8086/8088, 80186,80286, 80386 and 80486 Arcitecture, programming and interfacing, PHI, 8th Edition, 2009.
Reference Books	
1.	Douglas V. Hall, SSSP Rao Microprocessors and Interfacing Programming and Hardware. Tata McGraw Hill, Third edition, 2012.
2.	Mohamed Rafiquazzaman, Microprocessor and Microcomputer based system design, Universal Book stall, New Delhi, Second edition, 1995
3.	K Uday Kumar, B S Umashankar, Advanced Micro processors IBM-PC Assembly Language Programming, Tata McGraw Hill, 2002.
4.	Massimo Banzi,Getting Started with Arduino , First Edition, pub. O‟Reilly, 2008.
5.	John Uffenbeck and 8088 Family. 1997. The 80x86 Family: Design, Programming, and Interfacing (2nd ed.). Prentice Hall PTR, Upper Saddle River, NJ, USA.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	Arithmetic operations 8/16 bit using different addressing modes.	2.5 hours
2.	Finding the factorial of an 8 /16 bit number.	2.5 hours
3.	(a) Solving nCr and nPr (b) Compute nCr and nPr using recursive procedure. Assume that n and r are non-negative integers	2.5 hours
4.	Assembly language program to display Fibonacci series	2.5 hours
5.	Sorting in ascending and descending order	2.5 hours
6.	(a) Search a given number or a word in an array of given numbers. (b) Search a key element in a list of n 16-bit numbers using the Binary search algorithm.	2.5 hours
7.	To find the smallest and biggest numbers in a given array.	2.5 hours
8.	ALP for number system conversions.	2.5 hours
9.	(a) String operations(String length, reverse, comparison, concatenation, palindrome)	2.5 hours
10.	ALP for Password checking	2.5 hours
11.	Convert a 16-bit binary value (assumed to be an unsigned integer) to BCD and display it from left to right and right to left for specified number of times	2.5 hours
12.	ALP to interface Stepper motor using 8086/ Intel Galileo Board	2.5 hours
	Total Laboratory Hours	30 hours

Course code	Data Structures and Algorithms	L	T	P	J	C
CSE2011		3	0	2	0	4
Pre-requisite	Nil	Syllabus version				
		v. xx.xx				

Course Objectives:

1. To understand the basic concepts of data structures and algorithms.
2. To differentiate linear and non-linear data structures and the operations upon them.
3. Ability to perform sorting and searchingin a given set ofdata items.
4. To comprehend the necessity of time complexity in algorithms.

Expected Course Outcome:

1. Understanding the fundamental analysis and time complexity for a given problem.
2. Articulate linear data structures and legal operations permitted on them.
3. Articulate non-linear data structures and legal operations permitted on them.
4. Applying a suitable algorithm for searching and sorting.
5. Understanding graph algorithms, operations, and applications.
6. Understanding the importance of hashing.
7. Applying the basic data structures to understand advanced data structure operations and applications.
8. Application of appropriate data structures to find solutions to practical problems.

Module:1	Introduction to Algorithms and Analysis	6 hours

Overview and importance of algorithms and data structures. Fundamentals of algorithm analysis, Space and time complexity of an algorithm, Types of asymptotic notations and orders of growth, Algorithm efficiency – best case, worst case, average case, Analysis of non-recursive and recursive algorithms, Asymptotic analysis for recurrence relation – Recursive Tree Method.

Module:2	Linear Data Structures	8 hours

Array- 1D and 2D array , Stack - Applications of stack: Expression Evaluation - Conversion of Infix to postfix and prefix expression, Tower of Hanoi.

Queue - Types of Queue: Circular Queue, Double Ended Queue (deQueue), Applications – Priority Queue using Arrays - List - Singly linked lists – Doubly linked lists - Circular linked lists, Applications -Polynomial Manipulation - Josephus problem(permutation)

Module:3	Sorting and Search Techniques	8 hours

Searching - Linear Search and binary search, Applications - Finding square root of ‘n’-Longest Common Prefix

Sorting – Insertion sort - Selection sort – Bubble sort – (Counting Sort) - Quick sort- Merge sort , Analysis, Applications - Finding the ‘n’ closest pair’s

Module:4	Non-linear Data Structures - Trees	6 hours	CO:5,8

Tree - Terminology, Binary Tree – Terminology and Properties, Tree Traversals, Expression Trees – Binary Search Trees – operations in BST – insertion, deletion, finding min and max, Finding the kth minimum element in a BST, Applications – Dictionary

Module:5	Non-linear Data Structures - Graphs	6 hours	CO:3,8

Graph – basic definition and Terminology – Representation of Graph – Graph Traversal: Breadth First Search (BFS), Depth First Search (DFS) - Minimum Spanning Tree: Prim's, Kruskal's- Single Source Shortest Path: Dijkstra's Algorithm.			
Module:6	**Hashing**	**4 hours**	**CO:6,8**
Hash functions, open hashing-separate chaining, closed hashing - linear probing, quadratic probing, double hashing, random probing, rehashing, extendible hashing. Applications – Dictionary-Telephone directory			
Module:7	**Heaps and Balanced Binary Search Trees**	**5 hours**	**CO:7,8**
Heaps - Heap sort, Applications -Priority Queue using Heaps AVL trees – Terminology - basic operations(rotation, insertion and deletion			
Module:8	**Recent Trends**	**2 hours**	**CO:8**
Recent trends in algorithms and data structures			
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms , Third edition, MIT Press, 2009.
2	Mark A. Weiss,Data Structures & Algorithm Analysis in C++, 3rd edition, 2008, PEARSON.
Reference Books	
1.	Kurt Mehlhorn, and Peter Sanders – Algorithms and Data Sturctures The Basic Toolbox, Springer-Verlag Berlin Heidelberg, 2008.
2.	Horowitz, Sahni, and S. Anderson-Freed , Fundamentals of Data Structures in C UNIVERSITIES PRESS,Second Edition,2008.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Experiments (Indicative)		**CO:3,4,5**
1.	Implementation of Stack and its applications	4 hours
2.	Implementation of queue and its applications	4 hours

3.	Linked List	4 hours
4.	Searching algorithm	2 hours
5.	Sorting algorithm – insertion, bubble, selection etc.	2 hours
6.	Randomized Quick sort and merge sort	2 hours
7.	Binary Tree traversals	2 hours
8.	Binary search tree	2 hours
9.	DFS, BFS	3 hours
10.	Minimum Spanning Tree – Prim's and Kruskal's	3hours
11.	Single source shortest path algorithm – Connected Components and finding a cycle in a graph	2 hours
	Total Laboratory Hours	30 hours

Course code	Design and Analysis of Algorithms	L	T	P	J	C
CSE2012		3	0	2	0	4
Pre-requisite	CSE2011 – Data Structures and Algorithms	Syllabus version				
		v. xx.xx				

Course Objectives:

1. To provide a mathematical foundation for analyzing and proving the efficiency of an algorithm.
2. To focus on the design of algorithms in various domains of computer engineering.
3. To provide familiarity with main thrusts of work in algorithms sufficient to give some context for formulating and seeking known solutions to an algorithmic problem.

Expected Course Outcome:

On completion of this course, student should be able to

1. Ability to use mathematical tools to analyze and derive the running time of algorithms and prove thecorrectness.
2. Explain and apply the major algorithm design paradigms.
3. Explain the major graph algorithms and their analyses.
4. Explain the major String Matching algorithms and their analysis.
5. Explain the major Computational Geometry algorithms and their analysis.
6. Provide algorithmic solutions to real-world problem from various domains.
7. Explain the hardness of real world problems with respect to algorithmic efficiency and learning to cope with it.

Module:1	Algorithm Development	4 hours	CO: 1

Stages of algorithm development for solving a problem: Describing the problem, Identifying a suitable technique, Design of an algorithm, Proof of Correctness of the algorithm.

Module:2	Algorithm Design Techniques	10 hours	CO: 2

Brute force techniques – Travelling Salesman Problem, Divide and Conquer - Finding a maximum and minimum in a given array -Matrix multiplication: Strassen's algorithm, Greedy techniques Huffman Codes and Data Compression -Fractional Knapsack problem, Dynamic programming - O/1 Knapsack problem-Matrix chain multiplication, LCS, Travelling Salesman Problem, Backtracking-N-Queens Problem, Knights Tour on Chess Board.

Module:3	String Matching Algorithms	5 hours	CO:1,4

Naïve String matching Algorithms, KMP algorithm, Rabin-Karp Algorithm

Module:4	**Computational Geometry Algorithms**	**5 hours**	**CO:1,5**
Line Segments – properties, intersection; Convex Hull finding algorithms- Graham's Scan, Jarvis's March Algorithm.			
Module:5	**Graph Algorithms**	**6 hours**	**CO:1,3**
All pair shortest path – Floyd-Warshall Algorithm. Network Flows - Flow Networks, Maximum Flows – Ford-Fulkerson Algorithm, Push Re-label Algorithm, Minimum Cost Flows – Cycle Cancelling Algorithm.			
Module:6	**Complexity Classes**	**7 hours**	**CO:1,6**
The Class P, The Class NP, Reducibility and NP-completeness – SAT (without proof), 3-SAT, Vertex Cover, Independent Set, Maximum Clique.			
Module:7	**Approximation and Randomized Algorithms**	**6 hours**	**CO:7**
Approximation Algorithms - The set-covering problem – Vertex cover, K-center clustering. Randomized Algorithms - The hiring problem, Finding the global Minimum Cut			
Module:8	**Recent Trends**	**2 hours**	**CO:7**
	Total Lecture hours:	**45 hours**	

Text Book(s)

1.	Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms , Third edition, MIT Press, 2009.

Reference Books

1. Jon Kleinberg, ÉvaTardos ,Algorithm Design, Pearson education, 2014
2. Ravindra K. Ahuja, Thomas L. Magnanti, and James B. Orlin, "Network Flows: Theory, Algorithms, and Applications", Pearson Education, 2014.

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

Assignment: Exploring Finite Automata and String Matching

List of Experiments (Indicative)	**Total Hours: 30**
1. Design and implement an algorithm that multiplies two 'n' digit numbers faster than $O(n^3)$. 2. Design and implement an algorithm that will find the top and the least scores of students from an online Quiz. Note: The scores are stored in an array. 3. Design a solution for an Airline Customer on what to leave	

behind and what to carry based on cabin baggage weight limits. The Customer has to pack as many items as the limit allows while maximizing the total worth. The data can be shared in a CSV File. 1. Assume you have an unparenthesized arithmetic expression with only + and - operators. You can change the value of expression by parenthesizing at different positions. To keep it simple, assume that parenthesis occur only before or immediately after operands and not operators. Design an algorithm that can take a maximum possible value theexpression can take in after adding the parenthesis. 2. About 14 historic sites in Tamilnadu is shown in https://www.google.com/maps/search/historic+sites+in+tamilnadu/@10.7929896,78.2883573,7z/data=!3m1!4b1 Design a solution that identifies the shortest possible routes for a traveler to visit these sites. 3. Design a solution to see if a content C = PGGA is plagiarized in Text T = SAQSPAPGPGGAS. 4. You can find the schematics of Delhi Art Gallery (Ground Floor) in: https://www.archdaily.com/156154/delhi-art-gallery-re-design-vertex-design/50151feb28ba0d02f0000302-delhi-art-gallery-re-design-vertex-design-first-floor-plan Design a model to install fewest possible Closed Circuit Cameras covering all hallways and turns. 5. A maze has to be created and path has to be displayed which will be taken by the rat by using backtracking concept. 6. Consider x=aabab and y=babb. Each insertion and deletion has a unit 1) cost where as a change costs 2 units. Find a minimum cost edit sequence that transforms x into y by using suitable algorithm design technique. 7. Implement N-Queens problem and analyse its time complexity using backtracking. 8. Write a program to find all the Hamiltonian cycles in a connected undirected graph G(V,E) using backtracking 9. Design and implement a solution to find a subset of a given set S = {Sl, S2, ...,Sn} of n positive integers whose SUM is	

equal to a given positive integer d. For example, if S ={1, 2, 5, 6, 8} and d= 9,there are two solutions {1,2,6}and {1,8}. Display a suitable message, if the given problem instance doesn't have a solution.	

Course Code	Course title	L	T	P	J	C
MAT2010	Mathematical Methods for Computer Vision, Robotics, and Graphics	2	0	2	0	3

Pre-requisite	MAT1011 Calculus for Engineers	Syllabus Version
		1.0

Course Objectives

[1] Understanding basic concepts of linear algebra to illustrate its power and utility through applications to computer vision

[2] Apply the concepts of vector spaces, linear transformations, matrices and inner product spaces in engineering.

[3] Understanding the concepts of curves and surface

[4] Solving linear programming problems arise in engineering.

Course Outcome

At the end of this course the students are expected to learn

[1] the abstract concepts of matrices and system of linear equations using decomposition methods and applications in engineering

[2] understanding the geometry behind linear transforms which is used in computer graphics

[3] understanding the concepts of orthogonality through linear algebra

[4] understating properties curves and surfaces

[5] Solving linear programming problems arise in engineering

[6] Solving problems in Linear algebra, linear programming and differential geometry using matplotlib or Python.

Module:1	**Vectors and Matrices**	**3 hours**

Points, vectors, vector spaces(R^n only), lines and planes as subspaces -
Matrices and four fundamental spaces- Gaussian elimination.

Module:2	**Factorization of Matrices**	**5 hours**

LU factorizations-Cholesky decomposition –eigenvalues and eigenvectors-–SVD - Applications of the SVD .- Solving Linear Systems and the Pseudoinverse -Principal Components Analysis (PCA)

Module:3	**Linear transformations**	**3 hours**

Linear transformations(R^n only) – Basic properties-invertible linear transformation - matrices of linear transformations.

Module:4	**Geometry in Linear Transformation**	**4 hours**

Projections, Rotations and reflection and applications

Module:5	**Orthogonality**	**5 hours**

Dot products and inner products(R^n only) – lengths and angles of vectors –orthogonal matrices- Gram-Schmidt orthogonalizations-QR factorization- orthogonal projections–Least Square solutions

Module:6	**Differential geometry**	**4 hours**

Introduction to differential geometry - curves-curvature-torsion-osculating plane –surfaces

Module:7	**Linear programming**	**4 hours**

Linear programming – Formulation of LPP-Graphical method-Simplex method

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

Text Book(s)

1 Linear Algebra, Jin Ho Kwak and Sungpyo Hong, Second edition Springer(2004).
2 Mathematics for machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press, 2020.
3 Operations Research principles and applications, G.Srinivasan, 3rd edition, PHI learning, 2017
4 Differential Geometry of Curves and Surfaces: Revised and Updated Second Edition, Manfredo P. do Carmo, Dover publications 2016.

Reference Books

1 Linear Algebra and Optimization with Applications to Machine Learning - Volume I: Linear Algebra for Computer Vision, Robotics, and Machine Learning, Jean H. Gallier, Jocelyn Quaintance, World Scientific Publishing Company, 2020
2 Basics of Matrix Algebra for Statistics with R, Nick Fieller, CRC press, 2016
3 Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Cengage Learning (2015).
4 Modern Mathematics And Applications In Computer Graphics And Vision, Hongyu Guo, World scientific publishing company,2014
5 Computer Vision: A Modern Approach, Forsyth and Ponce, 2nd Edition Pearson 2012

Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.

List of Challenging Experiments

1.	Rank of a matrix, Solving linear system , LU decomposition , and Cholesky decomposition using Python/matplotlib	2 hours
2.	Eigenvalues and eigenvectors , SVD and getting Pseudoinverse using Python/matplotlib	2 hours
3.	Linear transformations -Examples of Rotations, Reflections in 2d with matplotlib (Original and reflected/rotated image to be shown)	2 hours
4.	Projection ,orthogonality, Gram-Schmidt and QR decomposition using Python/matplotlib	2 hours
5.	Applications of matrix multiplications and Convolutions using Python/matplotlib	3 hours
6	PCA and dimensionality reductions	3 hours
7	Recommender system	2 hours
8	Matrices applications – Page rank algorithm	2 hours
9	Visualizing curves using matplotlib	3 hours
10	Visualizing surfaces using matplotlib	3 hours
11	Solving Linear programming problems using matplotlib	3 hours
12	Optical Character Recognition	3 hours
	Total Laboratory Hours	**30 hours**

Course Code	Course Title	L	T	P	J	C
ECE2036	SIGNAL PROCESSING IN ROBOTICS	3	0	0	0	3

Pre-requisite	-	Syllabus Version
		1.0

Course Objectives:

1. To study various type of signals and its characteristics
2. To study various operations on the signals.
3. To analyze the signals using Fourier transform and Laplace Transform
4. To learn the fundamentals of robotics and sensor technology
5. To understand the controlling applications of robotics using sensor responses

Course Outcomes:

After the completion of the course, student will be able to:

1. To differentiate continuous and discrete time signals
2. To analyze the sensor response using Fourier transform
3. To analyze the trajectory of sensor signal using Laplace transform
4. To understand the signal conditioning and acquisition mechanism
5. To learn the fundamentals and peripherals of robots
6. To explore sensor responses in controlling robots
7. To explore various real-time application of sensor signal in robotics

Module:1	Introduction to Signals	5 hours

Continuous-time and Discrete-time Signals: Representation of signals, Signal classification, Types of signals, Operations on signals - Scaling, Shifting

Module:2	Fourier Analysis of Continuous-time Signals	6 hours

Introduction to Fourier series, Gibbs Phenomenon, Continuous-time Fourier transform (CTFT), Existence, Magnitude and phase response, Parseval's theorem, Inverse Fourier transform. Relation between Laplace and Fourier transforms, Laplace Transform, Magnitude and phase response

Module:3	signal conditioning	6 hours

Sensing - Pre-processing – Noise reduction, enhancement of details. Signal Conversion –Sampling, Quantization, Encoding

Module:4	Data Acquisition and sensing in Robotics	6 hours

Data Acquisition: Analog and digital data acquisition, single channel and multi-channel data acquisition
Image processing in Robotics: Vision sensor, Introduction to computer vision, Point operators, Linear Filters, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations.

Module:5	Fundamentals of Robotics	7 hours

Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.

Module:6	Drive Systems and Sensors in Robotics	7 hours

Drive system- hydraulic, pneumatic and electric systems.
Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, and Pressure sensors.

Module:7	Signal processing application in Robotics	6 hours

Robot applications: Application of robots in surgery, Manufacturing industries, space and underwater. Humanoid robots, Micro robots, Social issues and Future of robotics.

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	45 hours

Text Book(s)	
1.	Signals and Systems, second edition-P. Rama Krishna Rao and Shankar Prakriya- Mc-Graw Hill, 2013.
2.	Groover. M.P. Industrial Robotics, technology, programming and application Mc-Graw Hill 2012.
3.	S. R.Deb, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, 1994.
Reference Books	
1.	Signals and systems, second edition-Alan. V. Oppenheim, Alan. S. Willsk,S. Hamid Nawab, PHI learning Pvt ltd,1997
2.	Signals and systems, second edition - Simon Haykin, Barry VanVeen, Wiley, Wiley India, 2007.
3.	S. K. Saha, "Introduction to Robotics", Tata McGraw-Hill Publishing Company Ltd. (2008).
4.	Ramon Pallas-Areny, John G. Webster, "Sensors and Signal Conditioning", 2nd Edition, Wiley India Pvt. Ltd., India, 2012.
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.	

Course Code	Course title	L	T	P	J	C
CSE4082	ROBOT VISION	2	0	2	4	4

Pre-requisite		Syllabus Version
		1.0

Course Objectives:

1. To learn fundamental image processing and algorithms in vision
2. To learn vison based image Classification, object recognition and object detection
3. To be familiar about the applications regarding vision

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Understand the fundamentals of robotics and its applications.
2. Give an understanding of image processing for computer vision
3. Focus on early processing of images and the determination of structure: edges, lines, shapes
4. Apply computer vision to recognize objects , its trajectory and the basics of visual learning for the purpose of classification
5. Learn the applications of vision system in modern manufacturing environment

Module:1	Basics / Fundamentals	2 hours

Historical Perspective, Specifications of Robots, Classifications of robots, Work envelope, Flexible automation versus Robotic technology, Applications of Robots.

Module:2	Robot Sensing & Vision:	4 Hours

Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing, Digitizing, Image Processing and Analysis, segmentation- Thresholding- edge detection- binary morphology – grey morphology and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors, visual servo-control.

Module:3	Vision Algorithms	5 Hours

Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation – Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.

Module:4	Image Classification Algorithms	5 Hours

Regression, logistic regression, decision tree, support vector machine, random forest, naive Bayes, and k-nearest neighbor. Overview of SLAM, Different Approaches to SLAM: Kalman Filters ParticleFilters / Monte Carlo methods.

Module:5	Object Recognition	5 hours

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of depth values. Histogram of oriented gradients (HOG)

Module:6	Introduction to Object Tracking	4 hours

Exhaustive vs. Stochastic Search - Shapes, Contours, and Appearance Models. Mean-shift tracking; Contour-based models.

Module:7	Application of Robotics:	3 hours

Applications of robotics in active perception, medical robotics, autonomous vehicles, and other areas.

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.	
2.	Peter Corke, Robotics, Vision and Control: Fundamental Algorithms, Springer Tracts in Advanced Robotics,Volume 118, Second Edition, 2016	
Reference Books		
1.	David Forsyth and Jean Ponce, Computer Vision: A modern Approach, Prentice Hall India 2004	
2.	Klafter, Chmielewski and Negin, Robotic Engineering - An Integrated approach,, PHI, 1st edition, 2009.	
3.	Robert J. Schilling, "Fundamentals of Robotics Analysis and Control", PHI Learning, 2009.	
4.	Deb S R and Deb S, "Robotics Technology and Flexible Automation", Tata McGraw Hill Education Pvt. Ltd, 2010.	
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.		
List of Challenging Experiments (Indicative)		
1	Image Enhancement, Noise removal, Simple morphological operations, and Contouring of objects in an image.	6 hours
2	Edge Detection – Roberts and Sobel and Basic Transformations	6 hours
3	(i) Color Image Segmentation algorithm development (ii) Image recognition (recognizing simple objects based on features)	6 hours
4	(i) Implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets. (ii)Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.	6 hours
5	Tracking static and real-time objects.	6 hours
	Total Laboratory Hours	**30 hours**
Mode of Assessment: Continuous Assessment Test (CAT) / Final Assessment Test (FAT).		
Typical Projects (Tentative)		
1. Computer Vision for the Operation of Unmanned Aerial Vehicles. 2. Identifying different objects and classifying them. 3. Action understanding in human. 4. Augmented Human Assistance. 5. Gesture Interpretation for the Analysis of Interactions Humans/Robots/Humans. 6. Context Aware Vision using Image-based Active Recognition.		
Mode of Evaluation: Reviews		

Course Code	SENSORS, ACTUATORS AND SIGNAL CONDITIONING	L	T	P	J	C
ECE2035		2	0	2	4	4
Pre-requisite	None	Syllabus Version 1.0				

Course Objectives:

1. To summarize and analyze the different types of sensors, signal conditioning circuits, and actuators.
2. To introduce students the criteria for selecting a sensor for a particular measurement.
3. To elucidate students the types of actuators: electrical, pneumatic, and hydraulic and enlighten their operation.
4. To familiarize students with the basic techniques of designing the required signal conditioning for a particular sensor.

Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend, classify and analyze the behavior of different types of sensors.
2. Analyze the characteristics and performance measures of sensors and select suitable sensor for the given industrial applications.
3. Gain the knowledge about the types of actuators: electrical, pneumatic, and hydraulic, performance criteria and selection.
4. Elucidate the construction and working of various industrial parameters / devices used to measure temperature, pressure, flow, level and displacement.
5. Design the sensor interfacing and signal conditioning for various applications.
6. Implement the data acquisition systems with different sensors for real-time applications.
7. Realize the trends in sensor technology, industrial network and automation.
8. Conduct experiments and measurements in laboratory and realize hands-on experience on real components, sensors and actuators.

Module:1	Basics of Energy Transformation	2 hours
Introduction to sensors and transducers, Principle of sensing and transduction, Classification of sensors.		
Module:2	**Performance Characteristics of Sensors**	**4 hours**
Static characteristics: accuracy, precision, resolution, sensitivity, linearity, span and range - Dynamic characteristics, Mathematical model of transducer: zero, first and second, Response to impulse, step, ramp and sinusoidal inputs, Selection criteria of sensor.		
Module:3	**Actuator Performance and Selection**	**5 hours**
Electrical actuating systems: solid-state switches, solenoids and electric motors: DC motor, stepper motor, and Inertial measurement unit, Mechanical actuating systems: types of motion, kinematic chains, cams and gears, Pneumatic and hydraulic actuating systems: diaphragms, bellows and control valves.		
Module:4	**Measurement of Industrial Parameters**	**6 hours**
Measurement of temperature: thermistor and LM35, Measurement of pressure: strain gauge and piezoelectric type, Measurement of distance: ultrasonic, linear variable differential transformer and capacitance type, proximity sensor, Infrared sensor, Pulse oximeter and Tachometer.		
Module:5	**Signal Conditioning**	**5 hours**
Amplification, Filtering, Multiplexing, Conversion techniques, Sensor interface design: Wheatstone bridge and operational amplifier circuits for various applications.		
Module:6	**Data Acquisition System**	**3 hours**

Data Acquisition: single channel and multi-channel data acquisition, Data logging, Interfacing of sensors using DAQ cards, Applications: automobile and biological systems.		
Module:7	**Sensor Technology**	**3 hours**
Process of developing sensors, Trends in sensor technology and IC sensors, Sensor array's and multi-sensor systems, Smart sensors, Industrial network and automation.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	D. Patranabis, "Sensors and Actuators", 2nd Edition, PHI Learning, New Delhi, India, 2013.
2.	Ramon Pallas-Areny, John G. Webster, "Sensors and Signal Conditioning", 2nd Edition, Wiley India Pvt. Ltd., India, 2012.
Reference Books	
1.	D. Patranabis, "Sensors and Transducers", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, India, 2011.
2.	Jon S. Wilson, "Sensor Technology Hand Book", Newnes Publishing Company, Boston, USA, 2005.
3.	A.K. Sawhney, Puneet Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Co. Pvt. Ltd., New Delhi, India, 2014.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

List of Challenging Experiments (Indicative)

1	Interfacing of sensors for monitoring the physical quantities (distance, pressure, temperature, light intensity) and raising an alarm/ actuating a signal if the quantity exceeds specified limit.	6 hours
2	Measurements using proximity sensor and LiDAR sensor. Control of speed, direction and number of revolutions of a stepper motor.	6 hours
3	Obstacle avoidance robotic systems using servomotors, ultrasonic sensor and IR sensor.	6 hours
4	Design and test a signal conditioning circuits for the sensor interface: Instrumentation amplifier, filter and comparator.	6 hours
5	Interfacing data acquisition system hardware with computer to measure and control the robotic system.	6 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT).

Typical Projects

1. Contactless Liquid Level Controller
2. Speed Checker to Detect Rash Driving on Vehicles
3. Distance Measurement by Ultrasonic Sensor
4. Street lights that Glow on Detecting Vehicle Movement
5. Density Based Traffic Signal System using PIC Microcontroller
6. Generating Alarm through Over Temperature by Fan ON
7. Accident Detection System & Rescue System for Ambulance
8. Obstacle Avoidance Robotic Vehicle
9. Motion Detection, Robotics Guidance & Proximity
10. Door Opening System Automatically using IR Sensor & Microcontroller
11. Ultrasonic Sensor based Controlling System for Liquid Level
12. Fire alarm system with Smoke, Temperature Sensor using Arduino
13. Assistant for Car Parking using Distance Sensor
14. Battery Monitoring System using Microcontroller
15. Electrocardiogram (ECG) signal acquisition and monitoring

Mode of evaluation: Review I, II and III.

MAT1014	Discrete Mathematics and Graph Theory	L	T	P	J	C
		3	1	0	0	4
Pre-requisite	Nil	Syllabus Version				
		1.0				

Course Objectives:

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

Expected Course Outcome:

At the end of this course, students are expected to

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

Module:1	Mathematical Logic and Statement Calculus	6 hours

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

Module:2	Predicate Calculus	4 hours

The Predicate Calculus - Inference Theory of the Predicate Calculus.

Module:3	Algebraic Structures	5 hours

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

Module:4	Lattices	5 hours

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

Module:5	Boolean algebra	5 hours

Boolean algebra - Boolean Functions-Representation and Minimization of Boolean Functions – Karnaugh map – McCluskey algorithm.

Module:6	Fundamentals of Graphs	6 hours

Basic Concepts of Graph Theory – Planar and Complete graph - Matrix representation of Graphs – Graph Isomorphism – Connectivity–Cut sets-Euler and Hamilton Paths–Shortest Path algorithms.

Module:7	Trees, Fundamental circuits , Cut sets, Graph colouring, covering, Partitioning	12 hours

Trees – properties of trees – distance and centres in tree –Spanning trees – Spanning tree algorithms- Tree traversals- Fundamental circuits and cut-sets. Bipartite graphs - Chromatic number – Chromatic partitioning – Chromatic polynomial - matching – Covering– Four Colour problem.		
Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**
Tutorial	• A minimum of 10 problems to be worked out by students in every Tutorial class. • Another 5 problems per Tutorial Class to be given as home work.	**15 hours**
Mode of Evaluation		
Individual Exercises, Team Exercises, Online Quizzes, Online, Discussion Forums		
Text Book(s)		
1. Discrete Mathematical Structures with Applications to Computer Science, J .P. Trembleyand R. Manohar, Tata McGraw Hill-35th reprint, 2017. 2. Graph theory with application to Engineering and Computer Science, Narasing Deo, Prentice Hall India 2016.		
Reference Books		
1. Discrete Mathematics and its applications, Kenneth H. Rosen, 8th Edition, Tata McGraw Hill, 2019. 2. Discrete Mathematical Structures, Kolman, R.C.Busby and S.C.Ross, 6th Edition, PHI, 2018. 3. Discrete Mathematics, Richard Johnsonbaugh, 8th Edition, Prentice Hall, 2017. 4. Discrete Mathematics, S. Lipschutz and M. Lipson, McGraw Hill Education (India) 2017. 5. Elements of Discrete Mathematics–A Computer Oriented Approach, C.L.Liu, Tata McGraw Hill, Special Indian Edition, 2017. 6. Introduction to Graph Theory, D. B. West, 3rd Edition, Prentice-Hall, Englewood Cliffs, NJ, 2015.		
Mode of Evaluation		
Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test		

Course Code	Course title	L	T	P	J	C
CSE3115	ROBOT PROGRAMMING	2	0	2	4	4
Pre-requisite	CSE3102	Syllabus Version				
		1.0				

Course Objectives:

1. To introduce students the fundamentals of robotic programming
2. To summarize and analyze the different types of robot sensors and actuators.
3. To introduce students the criteria for selecting a sensor and actuator for a particular application.
4. To understand the Robot Operating System (ROS) fundamentals.
5. To introduce students the criteria for selecting a sensor and actuator for a particular ROS robotic application.
6. To understand integration of Arduino and Raspberry Pi boards with ROS.
7. To familiarize with various hardware based robotic application

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Understand the robotics design and implementation.
2. Gain the knowledge on fundamentals of robotic programming
3. Comprehend, classify and analyze the behavior of different types of sensors and actuators.
4. Understand the ROS fundamentals
5. Gain the knowledge about the types of actuators: electrical, pneumatic, and hydraulic, performance criteria and selection.
6. Design robotic applications using ROS
7. Design products by suitable integration of Arduino and Raspberry Pi boards with ROS

Module:1	**Robotics Introduction**	**3 hours**
Robot Introduction- Seven Criteria of Defining a Robot, Robot Controllers-Major Components, Robot Vocabularies- Robotics Middleware Basics.		
Module:2	**Programming the Robot's Sensors**	**4 hours**
A close look at Sensors, Programming the Robot's Sensors, Programming the Actuators , Building Robot's Softbot		
Module:3	**Robot Operating System (ROS)**	**5 hours**
ROS Basics-ROS Equation, History of ROS, Sensors and Robots Supporting ROS, ROS Architecture and Concepts, ROS Filesystem Level, ROS Computation Graph Level, ROS Community Level		
Module:4	**ROS Fundamentals**	**5 hours**
Ubuntu Linux for Robotics-Ubuntu Graphical User Interface, Shell Commands, C++ and Python for Robotic Programming- Basic Concepts with Examples		
Module:5	**ROS Programming**	**5 hours**
Creating ROS Workspace and Package, Using ROS Client Libraries, Programming Embedded Board using ROS-Interfacing Arduino with ROS, ROS on a Raspberry Pi		
Module:6	**Robotic Projects using ROS**	**3 hours**
Introduction to Wheeled Robots, Building Robot Hardware-Block Diagram and Assembling Robot Hardware, Programming Robot Firmware		
Module:7	**ROS Navigation**	**3 hours**
Localizing the robot in a map, ROS Navigation Stack-hardware requirement-navigation packages, path planning, motion planning of robot – software requirement and configuration.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)		
1.	Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018.	
2.	Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018.	
Reference Books		
1	Hughes, C. and Hughes, T., Robot programming: a guide to controlling autonomous robots. Que Publishing, 2016	
2	Quigley, M., Gerkey, B. and Smart, W.D., Programming Robots with ROS: a practical introduction to the Robot Operating System. " O'Reilly Media, Inc.", 2015	
3.	Anil Mahtani, Luis Sanchez, Enrique Fernandez, Aaron Martinez, Lentin Joseph. ROS Programming: Building Powerful Robots. Packt Publishing, 2018.	
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.		
List of Challenging Experiments (Indicative)		
1	Simulating Robotics arm using ROS	6 hours
2	Visualizing Robotic Sensor Data using ROS	6 hours
3	Installing ROS Navigation Stack-Implementing autonomous navigation	6 hours
4	Arduino-ROS: Working with path planning	6 hours
5	Interfacing Raspberry Pi Board to ROS for path planning application	6 hours
	Total Laboratory Hours	**30 hours**
Mode of Assessment: Continuous Assessment Test (CAT) / Final Assessment Test (FAT).		
Typical Projects (Indicative)		
1. Creating Robotics Arm 2. Creating differential wheeled Robot 3. Detecting and Tracking Colored Objects 4. Programming the Motor to move to a location and finding the distance covered 5. Applications using Vision Sensors 6. Building Differential Drive Mobile Robot		
Mode of Evaluation: Reviews		

Course Code	Course title	L	T	P	J	C
CSE4083	HUMANOID ROBOTICS	2	0	2	0	3
Pre-requisite	CSE2038	Syllabus Version 1.0				

Course Objectives:

1. To understand and describe the state of the art of humanoid robot.
2. To introduce students with mechanism and design of humanoid robot.
3. To elucidate the technical challenges with humanoid robot
4. To discuss the potential roles of humanoid robots in society, w.r.t. social and ethical aspects, and applications.

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend the technical aspects of various types of humanoid robot.
2. Gain the details of mechanism and design of humanoid robot.
3. Evaluate the ZMP and understand the dynamics of humanoid robot.
4. Generate the Biped walking pattern.
5. Understand the whole body motion of humanoid robot
6. Enable the rigid body dynamics of humanoid robot
7. Realize the trends of humanoid robot in society
8. Conduct experiments and measurements in laboratory and realize hands-on experience on real components, sensors and actuators.

Module:1	**Research on Humanoid Robot**	**4 hours**
Introduction, ASIMO and Humanoid Robot Research at Honda-Mobility-Task Performing-Communication Capabilities, NAO-Features-Applications-Technical & Ethical Challenges		
Module:2	**Humanoid Mechanism and Design**	**4 hours**
Kinematics, Characteristics of rotational motion, Velocity in 3D space, Kinematics of a Humanoid Robot.		
Module:3	**Zero Moment Point(ZMP) and Dynamics**	**5 hours**
ZMP overview, Measurement of ZMP, Dynamics of a humanoid robot, Calculation of ZMP.		
Module:4	**Biped Walking**	**4 hours**
2D and 3D walking pattern generation, ZMP-based walking pattern generation, Stabilizer, Additional methods for Biped control.		
Module:5	**Robot-Whole body motion**	**4 hours**
Rough whole body motion, Whole boy motion patterns to dynamically stable motion, remote operation of humanoid robot		
Module:6	**Dynamic Simulation**	**4 hours**
Dynamics of rotating rigid body, Spatial velocity, Dynamics of rigid body, Dynamics of link system		
Module:7	**Application of Humanoids**	**3 hours**
Humanoid Robots for Entertainment-Theme park, Humanoid Robots in Education-Robots role in teaching, Humanoid-like robot in Special Education, Next generation Industrial Robot, Inclusion of Humanoid Robots in Human Society-Ethical issues		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Ambarish Goswami and Prahlad Vadakkepat, "Humanoid Robotics: A Reference", Springer, Dordrecht, 2019.
2. Shuuji Kajita, Hirohisa Hirukawa, Kensuke Harada and Kazuhito Yokoi, "Introduction to Humanoid Robotics", Springer, Berlin, Heidelberg, 2014.

Reference Books

1. Cathrine Hasse and Dorte Marie Søndergaard, "Designing Robots, Designing Humans", 1st Edition, Routledge, London, 2019.

2.	Spiers, Adam, Khan, Said Ghani, Herrmann and Guido, "Biologically Inspired Control of Humanoid Robot Arms-Robust and Adaptive Approaches", Springer, Cham, 2016.	
3.	Dragomir Nenchev, Atsushi Konno and Teppei Tsujita, "Humanoid Robots-Modeling and Control", 1st Edition, Butterworth-Heinemann, USA, 2014.	
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.		
List of Challenging Experiments (Indicative)		
1	Getting introduced to NAO and make NAO to say 'Hello…'	6 hours
2	Make the joint angles of NAO to reach the desired end-effector position and orientation.	6 hours
3	Make NAO to identify the obstacles in the configuration space	6 hours
4	Design the NAO to take the valid path in the configuration space	6 hours
5	Make NAO to generate a proper motion trajectory	6 hours
	Total Laboratory Hours	**30 hours**
Mode of Assessment: Continuous Assessment Test (CAT) / Final Assessment Test (FAT).		

Course Code	Course title	L	T	P	J	C
CSE4084	NANO AND NEURO-ROBOTICS	3	0	0	0	3
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. To understand the Nano robotics design and implementation.
2. To elucidate students the types of Actuation Methods for Nano robotics.
3. To understand theory of Nano manipulation.
4. To familiarize students with the basic techniques of sensing and imaging techniques.
5. To acquire knowledge on Swarm Intelligence.
6. To apply Nanotechnology in Space robotics.
7. To comprehend the mechanism of neuro robotics.

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Understand the Nano robotics design and implementation.
2. Gain the knowledge on various types of Actuation Methods for Nano robotics.
3. Comprehend theory of Nano manipulation.
4. Familiar with the techniques of sensing and imaging.
5. Gain knowledge on Swarm Intelligence.
6. Apply Nanotechnology in design of space robotics.
7. Understand the mechanism of neuro robotics.

Module:1	**Nano robotics: Past, Present and Future**	**6 hours**
Introduction- Elements of Nano robots- Nano robots Architecture, Parts and Components – Applications.		
Module:2	**Actuation Methods for Nano robotics**	**6 hours**
Nano manipulation- System Components – Actuated Micro-robots –Nanotech: Nano bots – Optical Tweezers – Basics, History and Development.		
Module:3	**Theory of Nano manipulation**	**6 hours**
Dielectrophoresis and Optoelectronic Tweezers – DEP Force – Particle Separation by DEP –Stick-Slip Phenomenon.		
Module:4	**Sensing and Fast Imaging System**	**6 hours**
Image Sensor – Multispectral Imaging - CCD vs CMOS Technology – Satellites and Sensors – Seismic Data Reconstruction and Denoising – Nano spectroscopy – Atomic Force Microscopy.		
Module:5	**Swarms of Self-organized Nano robots**	**7 hours**
Swarm Robotics – Swarm Intelligence – Swarming Nano bots – Networking and Communication – Characteristics and Advantages of Swarm Robotics – Applications.		
Module:6	**Miniaturization and Micro/Nanotechnology in Space Robotics**	**6 hours**
Nano Technology Role – Nanostructures in Energy Harvesting – Nano technology in Space – Diamondoid Nano robotics.		
Module:7	**Neuro Robotics**	**6 hours**
Neuro Robotics – Human Machine Interfaces for Performance Augmentation – Rehabilitation Robotics.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Lynn V, Cooley K. , “Nanorobotics “, 1st Edition, Scientific e-Resources, 2018.
2.	Mavroidis, Constantinos, and Antoine Ferreira, “Nanorobotics: current approaches and techniques”, 1st Edition, Springer Science & Business Media, 2013.
3.	Artemiadis, Panagiotis, ed., “Neuro-robotics: From brain machine interfaces to rehabilitation robotics”, Vol. 2. Springer, 2014.
Reference Books	
1.	Parag Diwan, Ashish Bharadwaj , “Nanorobotics”, 1st Edition, Pentagon Press, 2006.
2.	Ning xi &Guangyoungli, “Introduction to Nanorobotic Manipulation & Assembly”, Artech house Press, 2012.
3.	Wang, Huanqing, “Neural & Bio-inspired Processing and Robot Control”, Frontiers Media SA, 2019.
4.	Yi Guo, “Selected Topics in Micro/Nano-robotic for Biomedical Applications”, Springer media, 2013.
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.	

Course Code	Course title	L	T	P	J	C
CSE2040	Drone Applications, Components and Assembly	3	0	2	0	4
Pre-requisite	CSE2038	Syllabus Version 1.0				

Course Objectives:

1. The aim of this course is to empower student to explore drones technology through their significant learning of the Components, Assembly and Calibrations.
2. Students will understand fundamental concepts of drone.
3. It ensures learning of various design models.
4. It also provide an open-access tool that facilitates drones' programming in different scenarios, applying concepts related to computer vision, artificial intelligence, automation, autonomous navigation, or control algorithms
5. It comprises a collection of lab exercises assembling drone applications in real life, such as following a road, visual landing, and people search and rescue, including their corresponding background theory.

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Understand UAV (Unmanned Aerial Vehicles) and its application along with Law enforcement required for deployment and testing
2. Gain the knowledge about the components required for UAV
3. Elucidate the drone assembly
4. Familiarize quadcopter calibrations
5. Acquaint Design models with Path planning and Navigation
6. Simulate and Deploy Drone for real life applications by conducting experiments that facilitates drones' programming with computer vision, artificial intelligence, automation, autonomous navigation, or control algorithms.

Module:1	Introduction of Unmanned Aerial Vehicles	6 hours

Introduction, Typical physical parameter, Categories of UAV, Law and Deployment Restriction on UAV, Small Unmanned Aerial Vehicle, Civilian and Military Application of UAV's.

Module:2	Components of Drone	7 hours

Drone Frames, Drone Motors, Sensors, Speed Controller, Flight Controller Board, Radio Transmitter and Receiver, Battery, Propellers, Connectors

Module:3	Drone Assembling	8 hours

Assembling the frame, Connecting the RC receiver and transmitter, Connecting Battery, Binding transmitter to the Receiver, Hovering, Rising/Climbing/taking off, Yaw, Protecting Drone from Crashing.

Module:4	Quadcopter	8 hours

ESP8266, Configuring Quadcopter, Frame type selection, Compass Calibration, Access calibration, Radio Calibration, Flight mode Calibration, Failsafe Calibration, GPS Tracker using ESP8266.

Module:5	Design Models	6 hours

Autopilot model, Kinematic Model of Controlled Flight, Kinematic Guidance Models, Dynamic Guidance Model.

Module:6	Path Planning and Navigation – I	4 hours

Path Planning: Point to Point Algorithm, Coverage Algorithm, Vision Guided Navigation: Glimbal and Camera Frames and Projective Geometry.

Module:7	Path Planning and Navigation – II	4 hours

Glimbal Pointing, Geolocation, Estimating Target Motion in the Image Plane, Time of Collision, Precision Landing

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

Text Book(s)

1.	A. R. Jha, Theory, Design, and Applications of Unmanned Aerial Vehicles (1st Edition), CRC Press, 2016. ISBN 978-1315371191
2.	Syed Omar FarukTowaha, Building Smart Drones with ESP8266 and Arduino: Build exciting drones by leveraging the capabilities of Arduino and ESP8266, Packt Publishing, 2018.
3.	Randal W. Beard and Timothy W. McLain: Small Unmanned Aircraft: Theory and Practice, Princeton University Press, 2012.

Reference Books

1.	Kenneth Munson, Jane's Unmanned Aerial Vehicles and Targets, (1st Edition), Jane's Information Group, United Kingdom ,1995, ISBN 978-0710612571.
2.	Rafael Yanushevsky, Guidance of Unmanned Aerial Vehicles (1st Edition), CRC Press 2011. ISBN 978-0429109898.

Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.

List of Challenging Experiments (Indicative)

List of Free/ Open Source Simulator:

- **Gazebo simulator** is a Robot simulator**.**
- PX4 is an open source flight control software for drones and other unmanned vehicles.

1	**<u>Position Control:</u>** The goal of this exercise is to implement a local navigation algorithm through the use of a PID controller. Note :Software installation and simulation set up (2 Hours)	4 hours
2	**Navigation by position:** This exercise aims to implement an autopilot by using the GPS sensor, the IMU, and a position-based PID controller. For this exercise, a simulated 3D world has been designed that contains the quadrotor and five beacons arranged in a cross. The objective is to program the drone to follow a predetermined route visiting the five waypoints in a given sequence. It illustrates the algorithms typically included in commercial autopilots such as ArduPilot or PX4.	2 hours
3	**Following an object on the ground:** In this exercise, the objective is to implement the logic that allows a quadrotor to follow a moving object on the ground, using a primary color filter in the images and a vision-based PID controller. The drone keeps its altitude and moves only in a 2D plane.	2 hours
4	**Landing on a moving car:** In this exercise, the student needs to combine pattern recognition and vision-based control to land on a predefined beacon, a four-square chess pattern on the roof of a moving car. The required image processing is slightly more complicated than a simple color filter, as the beacon may be partially seen, and its center is the relevant feature. Likewise, the controller needs to command the vertical movement of the drone	2 hours
5	**Escape from a maze using visual clue:** In this exercise, the student needs to combine local navigation and computer vision algorithms to escape from a labyrinth with the aid of visual clues. The clues are green arrows placed on the ground, indicating the direction to be followed. Pattern recognition in real-time is the focus here, as fast detection is essential for the drone.	2 hours
6	**Searching for people to rescue within a perimeter:** The objective of this exercise is to implement the logic of a global navigation algorithm to sweep a specific area systematically and efficiently, in conjunction with	2 hours

	visual face-recognition techniques, to report the location of people for subsequent rescue. The drone behavior is typically implemented as a finite state machine, with several states such as go-to-the-perimeter, explore-inside-the-perimeter, or go-back-home.	
7	Quadcopter Flying Training Simulator (Simulator).	2 hours
8	Hands on session on quadcopter (Hands-on): Implementation/ assembling of drone	4 hours
9	Testing Session (on field), Mount Arduino/Raspberry PI board on Drones,	4 hours
10	Application of drones such as surveillance, tracking, navigation, gesture control and agriculture,	2 hours
11	Deployment of deep learning model over RPi Board for different applications.	4 hours
	Total Laboratory Hours	**30 hours**
Mode of Assessment: Continuous Assessment Test (CAT) / Final Assessment Test (FAT).		

Course Code	Course Title	L	T	P	J	C
CSE3116	**Speech and Language Processing**	**3**	**0**	**0**	**4**	**4**
Pre-requisite		**Syllabus version**				
		v. 1.0				

Course Objectives:

1. Be competent with fundamental concepts for natural language processing and automatic speech recognition
2. To understand technologies involved in developing speech and language applications.
3. To demonstrate use of deep learning for building applications in speech and natural language processing

Expected Course Outcomes:

On completion of this course, the student will be able to

1. Describe ways to represent speech and words
2. Applying Machine Learning and Deep Learning for text mining tasks
3. Use signal processing techniques to analyze/represent the speech signal
4. Execute trials of speech/language systems

Module:1	**Introduction to NLP**	**5 hours**

Overview of NLP - Different levels of NLP – Problems with Syntax and Semantics - Corpora & their role in developing NLP applications – Text normalization

Module:2	**Feature Representation**	**6 hours**

One-Hot Encoding, Vector-Space Models, TF-IDF, Topic Modeling, N-grams – Smoothing – Perplexity, Word2vec embedding

Module:3	**Applications of NLP -I**	**6 hours**

Text Classification – Sentiment Analysis, Text Clustering, Named entities – CRFs for Named Entity Recognition, Text Summarization

Module:4	**Applications of NLP -II**	**7 hours**

IR based question answering system – Entity linking – Knowledge based Q&A – RNN and LSTM Networks– Chatbots – Machine translation – Encoder-decoder Networks – Beam search – Evaluation of translation.

Module:5	**Speech Production and Perception**	**4 hours**

Fundamentals of speech production – Short-Term Fourier representation of Speech – Functions of the ear – Perception of sound – Vocal tract model

Module:6	**Speech Signal Processing**	**5 hours**

Short-Time analysis of the signal – Energy – Zero crossing – Autocorrelation – Short time Fourier analysis - Spectrogram – Filter-banks – Cepstrum – Linear Predictive Coding – Mel-Frequency Cepstrum

Module:7	**Automatic Speech Recognition**	**10 hours**

Automatic Speech recognition formulation – Isolated word recognition – Large vocabulary continuous speech recognition – Deep learning for language modeling and automatic speech recognition – DNN/HMM Models – Evaluation metrics. Speaker recognition – Alexa/Google assistant based application development.

Module:8	**Contemporary issues**	**2 hours**

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Daniel Jurafsky & James H. Martin “Speech and Language Processing”, 3rd Ed., Draft Edition, 2020.	
2.	Nitin Indurkhya, Fred J. Damerau "Handbook of Natural Language Processing", Chapman and Hall/CRC , 2010.	
3.	Lawrence R. Rabiner, Ronald W. Schafe “Theory and Applications of Digital Speech Processing”, 1st Edn. Pearson, 2010.	
4.	Li Deng, Yang Liu "Deep Learning in Natural Language Processing", Springer, 2018.	
Reference Books		
1.	Digital Speech Processing Using Matlab, E. S. Gopi, Springer, 2014	
2	Voice Applications for Alexa and Google Assistant, Dustin Coates, Manning Publications, 2019.	
3	Speech and Audio Processing A MATLAB -based Approach, Ian Vince, McLoughlin, Cambridge Press, 2016.	
4.	Natural Language Processing with TensorFlow, Thushan Ganegedara, Packt, 2018	
5.	An Introduction to Voice Computing in Python, Jim Schwoebel, NeuroLex, 2018	
6.	Text Analytics with Python, Dipanjan Sarkar, Apress, 2019	
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.		
List of Projects (Indicative)		
1. Text Classification for Sentiment Analysis 2. Text Clustering 3. Biomedical Named Entity recognition 4. Speech Recognition for Indian Languages 5. Speaker Recognition		
Mode of Evaluation: Reviews		

Course Code	Course Title	L	T	P	J	C
CSE4085	**Medical Robotics**	3	0	0	0	3
Pre-requisite	**CSE4082**	**Syllabus Version**				
		1.0				

Course Objectives:

1. To provide knowledge on the application of robotics in health care
2. Sensor requirements for localization, control and tracking
3. Understand the design aspects of medical robots

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Identify the type of medical robots and the concepts involved in it.
2. Define the applications of surgical robotics
4. Purpose of Rehabilitation interface
5. Classify the types of assistive robots.
6. To analyze the design characteristics, methodology and technological choices for medical robots.

Module:1	**Introduction to Medical Robotics**	**4 hours**

Introduction to medical robotics : applications and paradigms – Role of AI in medical robotics – Potential impact of medical robots, types of medical robots and level of human intervention – growing healthcare challenges

Module:2	**Robotics in Healthcare**	**4 hours**

Surgical, Physical therapy, Bionic prosthetics, Care-Giver, Simulators, Pharmacy, Logistics

Module:3	**Image-Guided Interventions**	**6 hours**

Medical imaging modalities (e.g., MRI, US, X-ray, CT) - Robot compatibility with medical imagers - Image segmentation and modeling - Tracking devices - Frames and transformations - Surgical navigation - Calibration Rigid and non-rigid registration – Radiosurgery

Module:4	**Surgical Robotics**	**6 hours**

Medical robots: History, Characteristics of medical robots, Automation and Navigation Challenges - robotics in surgery: Laparoscopic and Endoscopic Manipulators, Oncology robotics, Physically assistive robotics, Socially assistive robotics

Module:5	**Minimally Invasive Surgery (MIS)**	**8 hours**

Human-machine interfaces - Teleoperation - Cooperative manipulation -Port placement for MIS - Robot design concepts - Video images in MIS - Augmented reality - Minimally invasive surgery training

Module:6	**Rehabilitation Robotics**	**8 hours**

Physiological basis of neuromotor recovery, Framework for neurorehabilitation robotics: implication and recovery, Actuators and sensors and prosthetic robots, Assistive controllers and modalities, Exoskeletons for upper limb and lower limb rehabilitation, Software platforms for integrating robots and virtual environments, Wearable robotic applications for neurorehabilitation

Module:7	**Medical robotics-applications, controversies and outcomes**	**7 hours**

Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics, Neurosurgery, Controversies and outcomes

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

Text Book(s)	
1.	Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall, 2003.
2.	Paula Gomes, "Medical robotics- Minimally Invasive surgery", Woodhead, 2012.
3.	J.J.Craig, Introduction to Robotics, Pearson Education, 2005.
4.	Roberto Colombo Vittorio Sanguineti, Rehabilitation Robotics, 1st Edition, Imprint: Academic Press Published Date: 10th March 2018, Springer
Reference Books	
1.	R. D. Howe and Y. Matsuoka, "Robotics for surgery," *Annual Review of Biomedical Engineering*, vol. 1, pp. 211–240, 1999.View at: Google Scholar
2.	A. R. Lanfranco, A. E. Castellanos, J. P. Desai, and W. C. Meyers, "Robotic surgery: a current perspective," *Annals of Surgery*, vol. 239, no. 1, pp. 14–21, 2004.
3.	S. Badaan and D. Stoianovici, "Robotic systems: past, present, and future," in *Robotics in Genitourinary Surgery*, pp. 655–665, Springer, New York, NY, USA, 2011.
4.	Introduction to Robotics : Mechanics and Control John J. Craig
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.	

Course code	Course Title	L	T	P	J	C
CSE3117	Internet of Things	2	0	2	4	4
Pre-requisite		Syllabus version				
		1.0				

Course Objectives:

1. To summarize and introduce various network, wireless, communications technologies, IoT Architecture and Security.
2. To introduce students the criteria for selecting the devices required for IoT.
3. To educate the students types of programming tools and interfaces.
4. To familiarize students with the basic techniques for designing that required for a particular domain specific IoT Solution.

Expected Course Outcome:

1. Identifies the basic fundamentals of IoT models and Design techniques.
2. Understood various network technologies involved with IoT.
3. Smart tools, security threats and technology implementation.
4. Issues involved with existing connectivity technologies and the advancement of health care towards Industry 4.0.

Module:1	**Basics of Internet of Things**	**4 hours**

Introduction to IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels and Deployment Templates

Module:2	**IoT Architecture & IoT Device**	**4 hours**

IoT Communication protocols, databases, Time-bases, Sensors, actuators, The IoT device design space, cost of owner ship and Power consumption, cost per transistor and chip size, Duty cycle and power consumption, platform design & Architectures

Module:3	**Event Driven System Analysis, Industrial IoT**	**5 hours**

IoT Network Model, IoT Event analysis, Introduction to Industry 4.0, Industrial IoT, IIoT Architecture, basic technologies, applications and challenges

Module:4	**Security & Safety**	**5 hours**

Introduction to system security, network security, generic application security, application process security and safety, design of reliable and secure IoT applications, Run-time Monitoring, The ARMET approach, privacy and dependability.

Module:5	**IoT Physical servers and cloud**	**4 hours**

Introduction to cloud storage models and communication APIs, WAMP, Python Web application Framework, Designing a RESTful Web API, Amazon Web Services for IoT

Module:6	**Domain Specific IoT**	**3 hours**

Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Health & Lifestyle

Module:7	**Development of IoT**	**3 hours**

IoT Platform Design Methodology, Example Device board, Device board interfaces, programming Raspberry in IoT, Data Analytics for IoT

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

Text Book(s)

1. Dimitrios Serpanos & Marilyn Wolf, “Internet of Things (IOT) System Architecures,Algorithms,

	Methodologies" Springer International publishing, AG 2018
2.	Arshdeep Bahga,Vijay Madiesetti, "Internet of Things A Handson Approach", 1st Edition, September 12,2014.
Reference Books	
1.	Greg Dunko, Joydeep Misra, Jodh Robertson & Tom Snyder,"A Reference Guide to tge Internet of Things", Bridgers LLC,2017.
2.	Vangelis Angelakis, Elias Tragos, Henrich C. Pöhls, Adam Kapovits, Alessandro Bassi, "Designing, Developing, and Facilitating Smart Cities Urban Design to IoT Solutions", Springer International Publishing Switzerland 2017.
3.	Michael Miller, "The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World Paperback ", Pearson Edition,Inc , 2015.

Mode of Evaluation: Continuous Assessment Test (CAT) / Assignments / Quiz / Final Assessment Test (FAT) / Seminar.

List of Challenging Experiments (Indicative)		
1.	Study on various sensors, actuators and its applications	3 hours
2.	Experiment using device interface board to measure distance of any object using Ultrasonic sensor.	3 hours
3.	Create a webpage and display the various values of the sensors interfaced with the device interface board	3 hours
4.	Students are required to submit an IOT based project using the Microcontroller or a Raspberry Pi and connecting various sensors and actuators. The data for the same should be displayed via a webpage or a web app	3 hours
5.	Demonstration of communication protocols of IoT using device interface board	3 hours
6.	Implement COAP to take the sensor reading with PUT, GET, POST and DELETE method	3 hours
7	Read the connected sensor reading from various nodes and display it in IoT gateway	3 hours
8	Randomly place five nodes in the environment, find the network topology using IoT gateway node and explain the captured results.	3 hours
9	Take the sensor readings from the node through gateway save it to cloud	3 hours
10	Data Gathering and Broadcasting in IoT	3 hours
	Total Laboratory Hours	30 hours

Mode of Assessment: Continuous Assessment Test (CAT) / Final Assessment Test (FAT).

List of Projects (Indicative)

1. Temperature Sensing and control
2. SmartSpaces Application
3. Mobile Smartspace application
4. Smart lighting
5. Smart Appliances
6. Smoke/Gas Detectors
7. Pollution Monitoring
8. Health monitoring
9. Smart irrigation
10. Remote vehicle diagnostics

Mode of Evaluation: Reviews

Course Code	Course title	L	T	P	J	C
CSE3118	Cyber Physical Systems	2	0	2	0	3
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. To learnt about design of cyber physical systems
2. To introduce students the different technological platforms and techniques for cyber physical systems
3. To elucidate students the modelling of cyber physical systems
4. To familiarize students with the basic techniques to perform analysis and verification for cyber physical systems

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Understand Cyber Physical systems and its design process
2. Ability to model the concepts of memory and interrupt architecture.
3. Analyze the different models of sensors, choosing to select appropriate suitable sensors and actuators. Understand the CPS network and the CPS real-time operating system.
4. Ability to understand model with the objective flow to design continuous to discreet systems.
5. Elucidate the modelling of hybrid systems. Understanding the composition of state machines and the different concurrent models of computation.
6. Analyze multitasking in CPS and ability to schedule CPS systems
7. Ability to perform verification and model checking
8. Conduct experiments and measurements in laboratory and realize on the state-of-the-art robot simulator CoppeliaSim

Module:1	Introduction to Cyber Physical Systems	2 hours

Introduction to Cyber Physical Systems; Cyber Physical Systems applications with example; Design process- Modelling, Design, Analysis.

Module:2	Memory Architectures	4 hours

Memory Technologies; Memory Hierarchy; Memory models; Interrupts and exceptions; Atomicity; Interrupt controller; Modelling interrupts.

Module:3	CPS- Platform Components	4 hours

Sensors and Actuators- models of sensors and actuators, common sensors, actuators; Embedded processors- types, parallelism; Network - WirelessHart, CAN, Automotive Ethernet; Software Stack.

Module:4	Continuous to Discreet Systems	6 hours

Modelling Continuous Dynamics – Introduction, Actor Based Modelling; Modelling of Discreet Dynamics- Notion of state, finite state machine, extended state machine, non-determinism, behavior and traces.

Module:5	Modeling Systems	5 hours

Hybrid Systems- Modals Models, Classes of hybrid systems; Composition of State Machines – Concurrent Composition, Hierarchical State Machines; Concurrent Models of Computation- Structure of models, synchronous reactive models, dataflow models of computation, timed models of computations

Module:6	Multitasking and scheduling	3 hours

Multitasking- Imperative programs, threads, processes and message passing; Scheduling- earliest deadline first, scheduling and mutual exclusion, multiprocessor scheduling.

Module:7	Analysis and Verification	4 hours

Invariants, Linear Temporal Logic- Propositional Logic Formulas, LTL Formulas, Reachability analysis- Open and closed systems, Reachability analysis, model checking.

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Second Edition, MIT Press, 2017.	
Reference Books		
1.	Rajeev Alur. Principles of Cyber-Physical Systems. First Edition, MIT Press. 2015.	
2	Raj Rajkumar, Dionisio de Niz, Mark Klein - Cyber-Physical Systems, First Edition, Addison-Wesley Professional, 2017.	
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar		
List of Challenging Experiments (Indicative)		
1	Introduction to CoppeliaSim, Familiarization with Script, coding, plugins in CoppeliaSim	6 hours
2	Implementation of different particle filter localization algorithm	6 hours
3	Implement an algorithm to guide a robot to particular location	6 hours
4	Familiarity with Robot Operating Systems	6 hours
5	Demonstration of building a model	6 hours
	Total Laboratory Hours	**30 hours**

Course code	Course title	L	T	P	J	C
CSE4086	Machine Diagnostics and Condition Monitoring	3	0	0	0	3
Pre-requisite	-	Syllabus version				
		1.0				

Course Objectives:

1. To summarize and analyze the different types of machines and related diagnostic procedures
2. To introduce students the criteria for identifying a condition monitoring technique for machine categories
3. To acquire basic skills of condition monitoring in smart machines
4. To familiarize students with the various signal processing and inferring techniques for quick diagnosis.

Expected Course Outcome:

1. Comprehend, classify and analyze the types of different electrical machines
2. Implement condition monitoring plan for complete Electrical System
3. Identify amount of damage/deterioration in the Equipment
4. Check the mechanical integrity of the equipment
5. Detect the of machine faults through ML algorithms
6. Apply various condition monitoring and maintenance techniques in real time

Module:1	Basics of Machinery failures	6 hours

Basic Concepts: Machinery failures, machine condition monitoring, transducer selection and location, PC interfacing and virtual instrumentation. Vibration signatures of faults in rotating and reciprocating machines; detection and diagnosis of faults.

Module:2	Signal analysis	6 hours

Time domain analysis – frequency domain analysis – non stationary signal analysis – modulation and beats – orbit and order analysis, Inferring signals: computer aided data acquisition – data recording - cepstrum analysis - Hillbert transform in condition monitoring

Module:3	Faults in Rotating Machines	5 hours

Introduction– Unbalance detection, field balancing, misalignment, crack and looseness. Intelligent fault detection: SVM, Artificial Neural Network – Fault root cause analysis using ML: Case study

Module:4	Introduction to condition monitoring	7 hours

The need for monitoring, What and when to monitor, Construction, operation and failure modes of electrical machines, Machine specification and failure modes, Failure sequence and effect on monitoring, Typical root causes and failure modes

Module:5	Predictive Condition Maintenance	7 hours

Predictive Condition Maintenance of Industrial Equipment's: Techniques for maintenance policies, ML Techniques in PdM: Linear Regression, Extreme Gradient Boosting Tress (XGBoost), Random Forest, Gradient Boosting Machines, Symbolic Regression – ML platforms: IBM Watson studio.

Module:6	Condition monitoring techniques	7 hours

Visual monitoring, Thermography, Vibration monitoring, Shock pulse monitoring, Wear debris monitoring, Acoustic emission, Ultrasound monitoring, ISO standards, Fault detection sensors

Module:7	Failure analysis	5 hours

Failure analysis, case-studies

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	45 hours

Text Book(s)

1	Balageas D., Fritzen C P. and Guemes A. - 'Structural Health Monitoring' - Published by ISTE Ltd., USA – 2006
2.	Clarence de Silva - 'Vibration and Shock Handbook'- CRC Taylor & Francis - 2005
Reference Books	
1.	Collacot - 'Mechanical Fault Diagnosis and Condition Monitoring'- Chapman - Hall - 1987
2.	Norton M. and Karczub D. – 'Fundamentals of Noise and Vibration Analysis for Engineers' – Cambridge University Press - 2003 - 2nd Edition
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar	

Course code	Course title	L	T	P	J	C
CSE3119	ROBOTIC PROCESS AUTOMATION	2	0	2	4	4
Pre-requisite	-	Syllabus version				
		v. 1				

Course Objectives:

1. To provide insights on robotic process automation (RPA) technology and its value proposition
2. To introduce different platforms for RPA
3. To illustrate basic programming concepts and the underlying logic/structure related to RPA
4. To describe the different types of variables, Control Flow and data manipulation techniques in a RPA platform
5. To describe automation to Email and various types of Exceptions and strategies to handle

Expected Course Outcome:

After the completion of the course, student will be able to:

1. Gain insights into Robotic Process Automation Technology
2. Demonstrate the underlying logic/structure related to RPA
3. Classify several types of data inside a workflow and, gain skills in building workflows in a RPA platform
4. Comprehend different types of variables, Control Flow and data manipulation techniques
5. Identify and understand Image, Text and Data Tables Automation
6. Demonstrate Desktop, Web and Citrix Automation
7. Design automation to Email and various types of Exceptions and strategies to handle

Module:1	Introduction to Robotic Process Automation	2 hours

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Future of RPA, Differentiating RPA from Automation, Defining Robotic Process Automation & its benefits, What RPA is Not, Types of Bots, Application areas of RPA, How Robotic Process Automation works, RPA development methodology and key considerations.

Module:2	Overview of Robotic Process Automation Tools	3 hours

Introduction to Robotic Process Automation Tools, Basic components in a RPA platform, Installation details of RPA tools, Types of Templates, User Interface, Domains in Activities, Workflow Files in the RPA platform.

Module:3	Process Components and Activities	6 hours

Process Components and Activities: User Interface Automation Activities, System Activities, Variables, Arguments, Imports Panel and User Events

Module:4	App Integration, Recording and Scraping	6 hours

App Integration, Recording, Scraping, Selector, Workflow Activities. Example of Automate login to your (web)Email account, Recording mouse and keyboard actions to perform an operation, Scraping data from website and writing to CSV.

Module:5	Data Manipulation and PDF Automation	5 hours

Data Manipulation, Automation of Virtual Machines, Introduction to Native Citrix Automation, Text and Image Automation, PDF Automation, Computer Vision.

Module:6	Programming, Debugging and Logging	3 hours

Programming, Debugging, Error Handling, Logging, Extensions, Project Organization

Module:7	Workflow Management Automation	3 hours

RPA Orchestrator Overview, Orchestrator activities, Introduction to Orchestrator Community Edition (CE).

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, Mumbai, 2018.	
2.	Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020.	
Reference Books		
1.	Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant" (1st Edition), Independently published, 2018. ISBN 978-1983036835	
2.	A Gerardus Blokdyk, "Robotic Process Automation Rpa A Complete Guide ", 2020	
3.	Frank Casale, Rebecca Dilla, Heidi Jaynes and Lauren Livingston, "Introduction to Robotic Process Automation: A Primer	
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar		
List of Challenging Experiments (Indicative)		
1.	Setup and Configure a RPA tool and understand the user interface of the tool: • Create a Sequence to obtain user inputs display them using a message box; • Create a Flowchart to navigate to a desired page based on a condition; • Create a State Machine workflow to compare user input with a random number.	6 hours
2.	Build a process in RPA platform using UI Automation Activities. • Create an automation process using key System Activities, Variables and Arguments • Also implement Automation using System Trigger	6 hours
3.	Automate login to (web)Email account	6 hours
4.	Recording mouse and keyboard actions to perform an operation Scraping data from website and writing to CSV	6 hours
5.	Different ways of Error Handling in RPA platform • Browse through the log files related to a RPA Project	6 hours
	Total Laboratory Hours	30 hours
Mode of assessment: Continuous Assessment Test(CAT) / Final Assessment Test (FAT).		
List of Projects – Indicative 1. Web Scraping 2. Data Migration/Entry and forms processing 3. Email Query Processing 4. Invoice Processing 5. Customer Support Emails		
Mode of evaluation: Reviews		

Course code	Course title	L	T	P	J	C
CSE4087	ADVANCED RPA DEVELOPER	2	0	2	4	4
Pre-requisite	CSE3119 Robotic Process Automation	Syllabus version				
		v. 1				

Course Objectives:

1. To provide insights on advances in robotic process automation (RPA) technology
2. To elucidate the business process of RPA
3. To describe roles and responsibilities of advance RPA developer
4. To illustrate advance programming concepts and the underlying logic/structure related to RPA

Expected Course Outcome:

After the completion of the course, student will be able to:

1. Comprehend RPA project lifecycle
2. Assess risk and challenges in RPA
3. Implement Robotic Enterprise Framework by following the rules of developing
4. Analyze security threats in RPA and compute cline security hash
5. Demonstrate advanced Web and Citrix Automation
6. Demonstrating skills for augmenting AI with RPA
7. Design and deploy intelligent bots

Module:1	Introduction to RPA Developer Role	2 hours

The RPA Developer Journey- About RPA Developer Foundation- Understanding the Business Process of RPA and famous use cases of RPA.

Module:2	RPA Advanced Concepts	4 hours

Standardization of processes, RPA Development methodologies, Difference from SDLC, Robotic control flow architecture, RPA business case, RPA Team, Process Design Document/Solution Design Document, Industries best suited for RPA, Risks& Challenges with RPA, RPA and emerging ecosystem.

Module:3	Advanced Automation concepts and techniques	6 hours

Introduction to Image & Text, Automation, Image based automation, Keyboard based automation, Information Retrieval, Advanced Citrix Automation challenges, Best Practices, Using tab for Images, Starting Apps.

Debugging and Exception Handling: Debugging Tools, Strategies for solving issues, Catching errors.

Module:4	Augmenting Automation with Artificial Intelligence (AI)	6 hours

Introduction to AI computer vision, Document understanding, AI chatbots.

Intelligent process automation: Benefits of Intelligent automation, Enabling End-to-End Automation with both RPA and AI.

Module:5	Implementing RE frame work	4 hours

Introduction to Robotics Enterprise (RE) Framework, About RE Framework, Purpose of RE Framework Using State Machine Layout, States of the State Machine, Workflows Involved, Workflows of the Framework, Exception Handling & Logging, Rules of Developing a Process using RE Framework.

Module:6	Project Organization and Deployment	3 hours

Choose the best project layout- Breaking down a complex process- Reusable templates- Managing versions of the same project- Industry best Practices- Deployment of Bots.

Module:7	Security Issues	3 hours

Security Issues in RPA, Prevention strategies for RPA security risks, UI Path security, Client security hash.

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, Mumbai, 2018.	
2.	Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020.	
Reference Books		
1.	Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant" (1st Edition), Independently published, 2018. ISBN 978-1983036835	
2.	A Gerardus Blokdyk, "Robotic Process Automation Rpa A Complete Guide ", 2020	
3.	Frank Casale, Rebecca Dilla, Heidi Jaynes and Lauren Livingston, "Introduction to Robotic Process Automation: A Primer	
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar		
List of Challenging Experiments (Indicative)		
1.	Bot Creation using recorders	6 hours
2.	Bot Creation for automating excel operations	6 hours
3.	Bot Creation to invoke database automation	6 hours
4.	Bot Creation for PDF Integrations	6 hours
5.	Bot Creation and working on error handling	6 hours
	Total Laboratory Hours	30 hours
Mode of assessment: Continuous Assessment Test(CAT) / Final Assessment Test (FAT).		
List of Projects – Indicative 1. Data Migration and Entry 2. Invoice Creation 3. Scheduling systems 4. Credit card applications 5. Call centre operations		
Mode of evaluation: Reviews		

Course Code	Course title	L	T	P	J	C
CSE3056	KNOWLEDGE REPRESENTATION AND REASONING	2	0	0	4	3
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. Introduce the techniques used to represent knowledge & associated methods for automated reasoning
2. Identifying knowledge-based techniques which are appropriate for specific tasks
3. Enable students to design and apply knowledge-based systems

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Discuss the foundations of KRR and represent knowledge using FOL
2. Understand how the knowledge can be used to represent commonsense worlds and key reasoning technique of Resolution theorem-proving
3. Design the Rule based system
4. Represent the knowledge using Object oriented approach
5. To generate the plans using knowledge about actions and assess the tradeoff between representation and reasoning
6. Apply KRR systems for challenging real-world problems

Module:1	Knowledge representation and First Order Logic	4 hours

Introduction - Use of Knowledge Representation in AI Systems, Methods for Knowledge Representation, Knowledge-based system - Knowledge representation-Reasoning - Role of Logic.

Introduction to FOL - Syntax – Semantics-Pragmatics -Explicit and Implicit Belief

Module:2	Expressing Knowledge	4 hours

Knowledge Engineering - Vocabulary - Basic Facts - Complex Facts - Terminological Facts Entailments - Abstract Individuals - Other Sorts of Facts.

Module:3	Resolution	4 hours

Resolution - The Propositional Case - Handling Variables and Quantifiers- Dealing with Computational Intractability

Module:4	Reasoning	4 hours

Horn Clauses - SLD Resolution - Computing SLD Derivations,

Procedural Control of Reasoning- Facts and Rules - Rule Formation and Search Strategy - Algorithm Design - Specifying Goal Order - Committing to Proof Methods - Controlling Backtracking - Negation as Failure - Dynamic Databases,

Rules in Production Systems- Basic Operation - Working Memory - Production Rules,

Module:5	Structured Descriptions	4 hours

Object-Oriented Representation- Objects and Frames,

Description Language -Meaning and Entailment - Truth in an Interpretation – Entailment - Computing Entailments -Simplifying the Knowledge Base - Normalization - Structure Matching - The Correctness of the Subsumption Computation -Computing Satisfaction - Taxonomies and Classification - A Taxonomy of Atomic Concepts and Constants - Computing Classification - Answering the Questions - Taxonomies versus Frame Hierarchies - Inheritance and Propagation

Module:6	Default reasoning	4 hours

Introduction, The Closed-World Assumption, Circumscription, Default Logic, Autoepistemic Logic

Module:7	Actions and Planning	4 hours

Actions- The Situation Calculus- A Simple Solution to the Frame Problem- Complex Actions

Planning - Planning in the Situation Calculus- The STRIPS Representation- Planning as a Reasoning Task, The Tradeoff between Expressiveness and Tractability

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

Text Book(s)

1. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
2. Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.

Reference Books

1. Murray Shanahan: A Circumscriptive Calculus of Events. Artificial Intelligence 77(2), pp. 249-284, 1995.

Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar

List of Projects – Indicative

Sample project titles are given below :

- Dynamic Knowledge Tracing in Computer supported Education
- Automated Reasoning for Situational Awareness
- Story planning

Mode of evaluation: Reviews

Course Code	Course title	L	T	P	J	C
CSE3057	REINFORCEMENT LEARNING	2	0	0	4	3
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. Model tasks as reinforcement learning problems.
2. Identify suitable algorithms and apply them to different reinforcement learning problems.
3. Design new reinforcement learning algorithms.

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Discuss possibilities and limitations of reinforcement learning.
2. Analyze relevant applications, decide if they can be formulated as a reinforcement learning problem.
3. Implement and use algorithms for reinforcement learning.
4. Analyze and evaluate methods through different performance criteria.

Module:1	Introduction to Reinforcement Learning	2 hours

Introduction to RL, Comparing with Supervised and Unsupervised Learning Algorithms, History of RL, Elements of RL, Limitations and Scope, Example: Tic-Tac-Toe

Module:2	Tabular Solution Methods: Markov Decision Process	5 hours

Markov chain and Markov process, MDP, Rewards and Returns, Episodic and Continuous tasks, policy and state value functions

Module:3	Dynamic Programming	5 hours

Iterative policy evaluation, Policy iteration, Value Iteration, Solving Frozen Lake problem using Value iteration and Policy Iteration

Module:4	Monte Carlo method	5 hours

Monte Carlo Methods, Predictions, first visit and every visit of Monte Carlo, Monte Carlo control, Markov Chain Monte Carlo method, On policy and off policy learning, Blackjack with Monte Carlo

Module:5	Temporal Difference method	5 hours

Overview TD (0), TD (1) and TD (λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.

Module:6	Deep Reinforcement Learning	3 hours

From tabular method to function approximator, curse of dimensionality, function approximator, Deep Reinforcement Learning: Value based, Policy based and Model based, Deep-Q Learning.

Module:7	Policy Gradient	3 hours

Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias, and variance in Reinforcement Learning, Reducing variance in policy gradient estimates

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

Text Book(s)

1. Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, Richard S. Sutton and Andrew G. Barto, A Bradford Book; 2018, ISBN 978-0262039246

Reference Books

1. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo (Eds.), Springer, 2012, ISBN 978-3642276446
2. An Introduction to Deep Reinforcement Learning, Vincent François-Lavet, Peter Henderson, Riashat Islam, Marc G. Bellemare and Joelle Pineau (2018), Trends in Machine Learning: Vol. 11, No. 3-4.

	DOI: 10.1561/2200000071.
3.	Algorithms for Reinforcement Learning, Csaba Szepesv´ari, Morgan & Claypool Publishers, 2009

Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar

List of Projects – Indicative

1. Traditional games: Backgammon- "TD-Gammon" game play using TD.
2. Traditional games: Chess- using Reinforcement Learning.
3. Computer games: Atari 2600 Games- Human level control through Deep Reinforcement Learning.
4. Computer games: Flappy Bird
5. Computer games: Mario- learning to play Mario with evolutionary reinforcement learning using artificial neural networks.
6. Computer games: StarCraft II
7. Robotics: Policy Gradient Reinforcement Learning for Fast Quadrupedal Locomotion
8. Robotics: Robot Motor Skill Coordination with EM-based Reinforcement Learning
9. Robotics: Autonomous Skill Acquisition on a Mobile Manipulator
10. Robotics: Black-Box Data-efficient Policy Search for Robotics
11. HCI: Optimizing Dialogue Management with Reinforcement Learning: Experiments with the NJFun System.

Mode of evaluation: Reviews

Course Code	Course title	L	T	P	J	C
CSE3058	**COGNITIVE ROBOTICS**	2	0	2	4	4
Pre-requisite		Syllabus Version 1.0				

Course Objectives:

1. To understand the main types of cognitive (vision, motor control, language, social skills) robots and their driving requirements (engineering operations, navigation, cooperation)
2. To understand advanced methods for creating highly capable cognitive robots
3. To dive into the recent literature, and collectively synthesize, clearly explain and evaluate the state of the art in cognitive robotics
4. To apply one or more core reasoning methods to create a simple agent that is driven by goals or rewards

Expected Course Outcome:

After the completion of the course, student will be able to:

1. Understand how our psychology and neuroscience understanding of behavior and intelligence informs the design of robotics models and applications
2. Compare, select and apply different machine learning methods for intelligent behavior in robots.
3. Analyse the methods and software/hardware technologies for robotics research and applications.
4. Discuss the state of the art in cognitive and intelligent robotics models, and how this informs the design of future robot applications.

Module:1	Introduction- Intelligent System Design and Cognition Development	2 hours

Thinking, Cognition, and Intelligence, Defining Intelligence - Embodiment and Its Implications, Synthetic Methodology for Intelligence.

Module:2	Cybernetic View of Robot Cognition And Perception	4 hours

Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, and Robot Cognition.

Module:3	Intelligent System Design, Cognition Development and control	5 hours

Properties of Complete Agents, Agent Design Principle, Developmental Robot Design, Matching brain and Body Dynamics, Artificial Neural Networks (ANN), Fuzzy Logic, Genetic Algorithms and Other Nature Inspired Methods, Optimal Control using ANN.

Module:4	Map Building	4 hours

Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Map Building.

Module:5	Randomized Path Planning	5 hours

Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, Planning with moving obstacles, Probabilistic Roadmaps, Rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

Module:6	Simultaneous Localization and Mapping (SLAM)	5 hours

Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, ParticleMethods Relation of Paradigms.

Module:7	Robot Programming methods	3 hours

Python Robot Programming Methods-:Go-to-Goal Behavior, Avoid-Obstacles Behavior, Hybrid Automata (Behavior State Machine),Follow-Wall Behavior. A Complete Program for autonomous mobile robot.

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Patnaik, Srikanta, "Robot Cognition and Navigation - An Experiment with Mobile Robots", Springer Verlag Berlin and Heidelberg, 2007
2.	Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.
3	David Vernon, "Artificial Cognitive Systems: A Primer" ,The MIT Press, 1st Edition,2014
Reference Books	
1.	Hooman Somani, "Cognitive Robotics", CRC Press, 2015
2.	Jared Kroff, "Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016
3.	https://www.toptal.com/robotics/programming-a-robot-an-introductory-tutorial

Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar

List of Challenging Experiments (Indicative)

1	Introduction to the Python language and Python libraries. • Installing Raspbian OS on the Raspberry Pi 3	4 hours
2	Introduction to microcontrollers (32-bit ARM-based devices) in embedded applications used in automobiles and home appliances (such as washing machines, microwave ovens, telephones, and computer system peripherals) • Controlling GPIO pins (e.g. connected to LEDs) on the Raspberry Pi 3 using Python • Controlling motors • Collecting sensor data (such as light-color sensor, touch sensor, infrared proximity sensor and ultrasonic sensor) • Writing and uploading robotic control programs	6 hours
3	Interfacing data acquisition system hardware with computer to measure and control the robotic system.	4 hours
4	Robotic motion and autonomous responses • Path following, solving a Rubix cube, book scanning, and other fun problems	6 hours
5	Machine learning algorithms for neural network pattern recognition	4 hours
6	Extend the deep learning exercises (e.g. Multi-Layer Perceptron (MLP) and/or Convolutional Neural Network (CNN) exercises for image datasets) to optimize the training for robotics (vision) applications.	6 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Continuous Assessment Test(CAT) / Final Assessment Test (FAT).

List of Projects – Indicative

1. Gaming Robots
2. Using SIFT for Object Recognition
3. Collaborative Map Building
4. Mirage World Builder
5. Robust landmark tracker
6. Improved Speech Generation For More Expressive Robots
7. Learning by autonomous exploration and reinforcement learning Robots
8. Recognition of human activities-Integration of sensorimotor learning and higher-level reasoning
9. Invent a project of your own interest

Mode of evaluation: Reviews

Course code	Course title	L	T	P	J	C
CSE3059	DRONES AND AUTONOMOUS SYSTEMS	3	0	2	0	4
Pre-requisite	CSE2040	Syllabus version				
		v. xx.xx				

Course Objectives:

1. To gain insight into the basic elements of commercial-off-the-shelf (COTS) drone systems used in civilian missions
2. To introduce unmanned aerial systems (UAS) including drones and autonomous unmanned aerial vehicles (UAV) with sensors
3. To Understand the regulatory procedures of drones, pilot certification and licensing and basic safety measures required of UAS / UAV.

Expected Course Outcome:

1. Understand the evolution and classification of Drones / Unmanned aerial Vehicle (UAVs)
2. Gain knowledge on UAVs technology side of things (i.e. sensors, platforms, navigation, power source, communication, range, altitude and speed)
3. Illustrate the commercial applications used by various types of drones such as aerial photography, law enforcement surveillance, and border enforcement.
4. Thorough knowledge on the hardware and software used for data collection, storage, analytical requirements and system life cycle.
5. Discuss Indian government airspace policy, regulations, and a comparison of other international regulations, and risk factors
6. Realize the emerging technologies being integrated into the drone market including semi-autonomous and autonomous systems for various applications like crop sensing, emergency response missions, and coordinated swarms

Module:1	Introduction to Autonomous Flights	4 hours

History of Autonomous Flights – Principles of Flight – Flight Maneuvers – Showcase of DIY drones

Module:2	Technologies and Requirements	6 hours

Critical Technologies – Navigation, Sensors and Payloads, Power Sources, Communications – COTS Drone Technologies

Module:3	Design Fundamentals	6 hours

UAV Classifications – Review of few Successful UAVs – Design Project Planning – Feasibility Analysis- Design Process – UAV Conceptual Design – UAV Preliminary Design – UAV Detail Design – Design Review, Evaluation, Feedback – UAV Design Steps

Module:4	Principles of UAVs	6 hours

Airframe - Building the Little Dipper Airframe – Step by step build instructions – Power Train – Propellers – Motors – Total Lift – Wrapping UP

Module:5	Control and Navigation	8 hours

Flight Controller – Build Instructions of Flight Controller – GPS – Compass – Battery Monitor – Transmitter – Frequency Bands – Different Modes Around the World

Module:6	Telemetry Radios, Camera and First Person View (FPV) Equipment	6 hours

Software Monitoring and control – Popular Drone Cameras – FPV for Live stream – Key Flight Safety Rules – PreFlight Checklist and Flight Log information – Laws and Regulation

Module:7	Overview of Commercial Drones and Kits	7 hours

Parallax ELEV-8 Quadcopter - DJI Phantom 2 Vision - OpenROV - Actobotics Nomad - Brooklyn Aerodrome Flack – Choosing Between Commercial Options – Making your own Airframe

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

Text Book(s)	
1.	Terry Kilby and Belinda Kilby Make: Getting Started with Drones, First Edition, Maker Media Inc, San Francisco CA, 2016
2.	John Baichtal "Building your own Drones A beginners Guide to Drones, UAVs and ROVs", Que Publishing 2016
Reference Books	
1.	Mohammad H. Sadraey "Design of Unmanned Aerial Systems" First Edition, John Wiley & Sons, Inc., USA 2020
2.	A. R. Jha, "Theory, Design, and Applications of Unmanned Aerial Vehicles", First Edition, CRC Press, 2020
3.	Alain Cardon and Mhamed Itmi "New Autonomous Systems" Volume 1, John Wiley & Sons, Inc. Hoboken, USA. 2016

Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar

List of Challenging Experiments (Indicative)		
1.	Basic building blocks and 3D Design of a Drone	6 hours
2.	Making the drone to be stable and fly autonomously with little human intervention	6 hours
3.	Design a control system architecture that will hover a quadcopter	6 hours
4.	How to create flight software from the control architecture	6 hours
5.	How a good model of the drone and the environment it operates in can be used for simulation and test. Tuning the PID Controller	6 hours
	Total Laboratory Hours	30 hours

Mode of Assessment: Continuous Assessment Test(CAT) / Final Assessment Test (FAT).

Course Code	Course title	L	T	P	J	C
CSE3060	ROBOTICS BASED INDUSTRIAL AUTOMATION	3	0	0	0	3
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. To understand the role of Robotics in Industrial Automation.
2. To discuss about the various applications of robots, justification and implementation in Industry Automation.
3. To design automatic manufacturing cells with robotic control using the principle behind Robotics
4. To identify and explain potential areas of automation in manufacturing industry using Robotics.
5. To differentiate the various control aspects of automation in Industry.
6. To design components and systems related to industrial automation considering the economic, social, manufacturability and sustainability aspects.

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Know the Current state of robotics and relevant industrial applications
2. Determine where robotics fits in industrial applications.
3. Importance to automate including fixed, programmable, and flexible modes of operations towards Robotics.
4. Elucidate the conceptual place of robotics in industrial automation.
5. Analyze the process where the robot will be participating.

Module:1	Introduction	6 hours

Definition, automation principles and strategies, scope of automation, socio-economic consideration, low cost automation, basic elements of advanced functions, Information processing in manufacturing industry, Production concepts and automation strategies.

Module:2	Fixed Automation	6 hours

Fixed Automation: Automated Flow lines, Methods of Work part Transport, Transfer Mechanism - Continuous transfer, intermittent transfer, Indexing mechanism, Operator-Paced Free Transfer Machine, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations.

Module:3	Analysis of Automated Flow Lines	6 hours

Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines without Storage, Partial Automation, Automated Flow Lines with Storage Buffers.

Module:4	Automated Assembly Systems and Line Balancing	7 hours

The Assembly Process, Assembly Systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Computerized Line Balancing Methods.

Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Vibratory bowl feeder and Non vibratory bowl feeder, Part Orienting Systems, Feed tracks, Escapements and part placing mechanism, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.

Module:5	Automated Material Handling	6 hours

The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems.

Module:6	Automated Storage System	6 hours

Storage System Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing.		
Module:7	**Automated Inspection and Testing**	**6 hours**
Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Mikell P. Grover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education Asia, 2001.
2.	C. RayAsfahl, "Robots and manufacturing Automation", John Wiley and Sons New York, 1992.
Reference Books	
1.	Viswanandham N., "Performance modeling of automated Manufacturing Systems", PHI, 1992.
2.	Viswanathan, N., and Narahari,Y., "Performance Modeling and Automated Manufacturing Systems", Prentice Hall of India Pvt. Ltd., 2000.
3.	Deb S. R., "Robotics Technology & Flexible Automation" Tata McGraw Hill, 2001.
4.	Thomas R. Kurfess, "Robotics and Automation Handbook" 1 ed., CRC Press 2005.
5.	Stephen J. Derby, "Design of Automatic Machinery", Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai, 2004.
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar	

Course Code	Course title	L	T	P	J	C
CSE1022	FOUNDATIONS OF ROBOTICS: KINEMATICS, DYNAMICS AND MOTION CONTROL	2	0	2	4	4
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. To summarize and analyze the fundamentals of robotics.
2. To introduce students the kinematics and dynamics of robots.
3. To elucidate students the types of motion control.
4. To familiarize students with the basic techniques of designing the robots.

Expected Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend, classify and analyze the fundamentals of robotics.
2. Analyze the kinematics in robots.
3. Gain the knowledge about the dynamics of robots.
4. Elucidate the motion control in robotics.

Module:1	Fundamentals	2 hours
Introduction – Components, Degrees of Freedom, Joints, Coordinates, Mechanisms, Controller.		
Module:2	**Kinematics**	**6 hours**
Position and Orientation of Objects, Coordinate Transformation, Joint Variables and Position of End Effector, Inverse Kinematics Problem, Jacobian Matrix, Statics and Jacobian Matrices.		
Module:3	**Dynamics**	**7 hours**
Lagrangian and Newton-Euler Formulations, Derivation of Dynamics Equations Based on Lagrangian Formulation, Derivation of Dynamic Equations Based on Newton-Euler, Formulation, Use of Dynamics Equations and Computational Load, Identification of Manipulator Dynamics.		
Module:4	**Manipulability**	**4 hours**
Manipulability Ellipsoid and Manipulability Measure, Best Configurations of Robotic Mechanisms from Manipulability Viewpoint, Various Indices of Manipulability, Dynamic Manipulability.		
Module:5	**Position Control**	**5 hours**
Generating a Desired Trajectory, Linear Feedback Control, Two-Stage Control by Linearization and Servo Compensation, Design and Evaluation of Servo Compensation, Decoupling Control, Adaptive Control.		
Module:6	**Force Control**	**3 hours**
Impedance Control - Passive-Impedance Method, Active-Impedance Method-One- Degree-of- Freedom Case, Active-Impedance Method-General Case.		
Module:7	**Hybrid Control**	**2 hours**
Hybrid Control - Hybrid Control via Feedback Compensation, Dynamic Hybrid Control.		
Module:8	**Contemporary issues**	**1 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Tsuneo Yoshikawa, "Foundations of Robotics Analysis and Control", The MIT Press Cambridge, 1990.
2. Saeed B Niku, “Introduction to Robotics Analysis, Control, Applications”, 3rd Edition, Wiley, 2020.

Reference Books

1. Robert J. Schilling, “Fundamentals of Robotics, Analysis and Control”, Prentice Hall India, 2003.
2. John J. Craig, “Introduction to Robotics, Mechanics and Control”, 3rd Edition, Pearson Prentice Hall, 2005.

Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT)

/ Seminar.		
List of Challenging Experiments (Indicative)		
1	Kinematics simulation	6 hours
2	Dynamics simulation	6 hours
3	Manipulability simulation	6 hours
4	Position control – simulation / hardware	6 hours
5	Force control – simulation / hardware	6 hours
	Total Laboratory Hours	**30 hours**
Mode of Evaluation: Continuous Assessment Test(CAT) / Final Assessment Test (FAT).		
List of Projects – Indicative		
1. Gesture controlled robot using Micro sensors 2. Automatic Sorting robotic system using machine vision 3. Low cost Agri-Rover 4. Automatic irrigation system using Humanoid 5. A Novel design of Egg picking Robot 6. A robot cell design for an Automatic greasing system 7. Design of underwater robot for surveillance purpose 8. Design of a mobile robot using dynamic path planning algorithm		
Mode of evaluation: Reviews		

Course code	Course title	L	T	P	J	C
CSE4088	DEEP LEARNING : PRINCIPLES AND PRACTICES	2	0	2	0	3
Pre-requisite		Syllabus version				
		v. 1.0				

Course Objectives:

1. 1. Introduce major deep neural network frameworks and issues in basic neural networks.
2. To solve real world applications using Deep learning.

Expected Course Outcome:

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.
2. Identify and apply suitable deep learning approaches for given application.
3. Design and develop custom Deep-nets for human intuitive applications.
4. Design of test procedures to assess the efficiency of the developed model.

Module:1	NEURAL NETWORKS	4 hours

Introduction of Artificial Neural Networks (ANN) - Functions in ANN – Activation function, Loss function - L1, L2 - Function approximation, classification / clustering problems - Applications

Module:2	LEARNING IN DEEP NETWORKS	4 hours

Back propagation training, Learning the weights, Chain rule, Stochastic gradient descent, Sigmoid units and vanishing gradient, Rectified Linear Unit (ReLU) and its variants - Cross entropy for classification and activation, Batch learning.

Module:3	IMPROVING DEEP NEURAL NETWORKS	6 hours

Hyper-parameter tuning, Regularization - Dropouts, Minibatch gradient descent, Data Augmentation, Stratification, Generalization Gap – Under-fitting Vs Over-fitting - Optimization – Momentum, Learning rate schedules, AdaGrad, RMSProp and Adam optimization, Internal Co-variant and Batch Normalization, Initialization – weights, Bias

Module:4	CONVOLUTION NEURAL NETWORKS	5 hours

CNN Operations, Pooling, Basic architecture, Variants of the Basic Convolution Model – Advanced architectures : AlexNet, ResNet and others.

Module:5	RECURRENT NETWORKS	3 hours

Recurrent Neural Networks - Bidirectional RNNs, Encoder, Decoder, Sequence-to-Sequence Architectures, Deep Recurrent Networks, Auto encoders

Module:6	RECURSIVE NEURAL NETWORKS	3 hours

The Challenge of Long-Term Dependencies, Echo State Networks, Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory

Module: 7	TRANSFER LEARNING, GENERATIVE ADVERSARIAL NETWORKS	4 hours

Transfer Learning strategy, GAN and their variants, R-CNN , YOLO and SSD

Module:8	CONTEMPORARY ISSUES	1 hour

	Total Lecture:	30 Hours

Text Book(s)

1. Deep Learning, Ian Goodfellow Yoshua Bengio Aaron Courville, MIT Press, 2017
2. Neural Networks and Deep Learning, Michael Nielsen,, Determination Press

Reference Books

1. Deep Learning Step by Step with Python, N D Lewis, 2016

2	Deep Learning: A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly Media, 2017	
3	Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks, Umberto Michelucci, Apress, 2018.	
4	Deep Learning with TensorFlow: Explore neural networks with Python, Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy, Packt Publisher, 2017.	
5	Deep Learning with Keras, Antonio Gulli, Sujit Pal , Packt Publishers, 2017.	
6	Deep Learning with Python", Francois Chollet, Manning Publications, 2017.	
Mode of Evaluation: Continuous Assessment Test (CAT) / Assignment/ Quiz/ Final Assessment Test (FAT) / Seminar.		
List of Challenging Experiments (Indicative)		
1.	Demonstration and implementation of Shallow architecture, using Python, Tensorflow and Keras • Google Colaboratory - Cloning GitHub repository, Upload Data, Importing Kaggle's dataset, Basic File operations • Implementing Perceptron, • Digit Classification : Neural network to classify MNIST dataset	10 hours
2.	Hyper parameter tuning and regularization practice - • Multilayer Perceptron (BPN) • Minibatch gradient descent,	4 hours
3.	Convolution Neural Network application using Tensorflow and Keras, • Classification of MNIST Dataset using CNN • Face recognition using CNN	4 hours
4.	Object detection using Transfer Learning of CNN architectures	2 hours
5.	Image denoising (Fashion dataset) using Auto Encoders • Handling Color Image in Neural Network aka Stacked Auto Encoders (Denoising)	2 hours
6	Text processing, Language Modeling using RNN	2 hours
7	Time Series Prediction using RNN	2 hours
8	Sentiment Analysis using LSTM	2 hours
9	Image generation using GAN	2 hours
	Total Laboratory Hours	30 hours
Mode of Evaluation: Continuous Assessment Test(CAT) / Final Assessment Test (FAT).		

Course Code	Foundations of Data Analytics	L	T	P	J	C
CSE3505		2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To establish clearly the objectives and scope of the predictive analysis
2. Use R programming language to identify suitable data sources to agree the methodological approach
3. Validate and review data accurately and identify anomalies
4. To appreciate the current trends in data analysis procedure
5. Carry out rule-based analysis of the data in line with the analysis plan
6. Apply statistical models to perform Regression Analysis, Clustering and Classification
7. Present the results and inferences from your analysis using R tool
8. To improve document management and team work

Expected Course Outcome:

Students will be able to:

1. Understand R with Business Intelligence, Business Analytics, Data and Information
2. Contextually integrate and correlate information automatically to gain faster insights
3. Implement statistical analysis techniques for solving practical problems.
4. Graphically interpret data and Find a meaningful pattern in data
5. Perform statistical analysis on variety of data.

Module:1	Introduction to Analytics	4 hours

Analytics life cycle - Business analytics - lending analytics- recommendation analytics- Healthcare Analytics- financial analytics - sports analytics

Module:2	R programming Basics	5 hours

Introduction to R, R Studio (GUI): R Windows Environment, introduction to various data types, Numeric, Character, date, data frame, array, matrix etc.,

Module:3	Working with datasets and files:	6 hours

Reading Datasets, Working with different file types .txt,.csv , R studio, Files, Datasets, Extracting Datasets, Preparing datasets. Data Cleaning, Data imputation, Data conversion Analysis

Module:4	Introduction to statistical learning and R-Programming	6 hours

Basic statistics: mean, median, standard deviation, variance, correlation, covariance - Outliers, Combining Datasets in R, Functions and loops. Summary Statistics - Summarizing data with R - Correlation and Regression

Module:5	Document Creation and Knowledge Sharing:	3 hours

Access existing documents, language standards, templates and documentation tools from their organization's knowledge base. Confirm the content and structure of the documents with appropriate people, Create documents using standard templates and agreed language standards. Review documents with appropriate people and incorporate their inputs

Module:6	Self and work Management:	3 hours

Establish and agree their work requirements with appropriate people - Keep their immediate work area clean and tidy - utilize their time effectively - Use resources correctly and efficiently - Treat confidential information correctly - Work in line with organization's policies and

procedures - Work within the limits of their job role		
Module:7	**Team Work and Communication**	**3 hours**
Communicate with colleagues clearly, concisely and accurately - Work with colleagues to integrate their work effectively with them - Pass on essential information to colleagues in line with organizational requirements - Work in ways that show respect for colleagues - carry out commitments they have made to colleagues - Let colleagues know in good time if they cannot carry out their commitments, explaining the reasons - Identify any problems they have working with colleagues and take the initiative to solve these problems		
	Total Lecture hours	**30 hours**
Text Book(s)		
1.	Trevor Hastie and Rob Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 2017.	
2.	Mark van der Loo, Edwin de Jonge, "Learning R Studio for R Statistical Computing", Packt Publishing, 2012.	
3.	Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. "Mining of Massive Datasets". Cambridge University Press. 2014.	
Reference Books		
1.	Hadley Wickham and Garrett Grolemund, "R for Data Science: Import, Tidy, Transform, Visualize, and Model Data", O'Reilly, 2017.	
2.	Grolemund, Garrett. "Hands-on programming with R", O' Reilly Media, Inc., 2014.	
3.	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval", Cambridge University Press, First South Asian Edition, 2008.	
4.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, Second Edition, 2011.	
5.	https://www.sscnasscom.com/qualification-pack/SSC/Q2101/	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	Understanding of R System and installation and configuration of R-Environment and R-Studio, Understanding R Packages, their installation and management	3 hours
2.	Understanding of nuts and bolts of R: a. R program Structure b. R Data Type, Command Syntax and Control Structures c. File Operations in R	3 hours
3.	Dataframes and lists	3 hours
4.	Excel and R integration with R connector.	3 hours
5.	Preparing Data in R a. Data Cleaning b. Data imputation c. Data conversion	3 hours
6.	Manipulating Matrices in R	3 hours
7.	Outliers detection using R	3 hours
8.	Correlation and N-Fold cross validation in R	3 hours
9.	Debugging and Program Efficiency in R	3 hours
10.	Visualizing data using R with different type of graphs and charts	3 hours
	Total Laboratory Hours	**30 hours**

Course Code	Essentials of Data Analytics	L	T	P	J	C
CSE3506		2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To understand the concepts of analytics using various machine learning models.
2. To appreciate supervised and unsupervised learning for predictive analysis
3. To understand data analytics as the next wave for businesses looking for competitive advantage
4. Carry out rule-based analysis of the data in line with the analysis plan
5. Validate the results of their analysis according to statistical guidelines
6. Validate and review data accurately and identify anomalies
7. To learn aspects of computational learning theory
8. Apply statistical models to perform Regression Analysis, Clustering and Classification

Expected Course Outcome:

1. Identify and apply the appropriate supervised learning techniques to solve real world problems with labelled data.
2. Choose and implement typical unsupervised algorithms for different types of applications with unlabelled data.
3. Implement statistical analysis techniques for solving practical problems.
4. Understand different techniques to optimize the learning algorithms.
5. Aware of health and safety policies followed in organization, data and information management and knowledge & skill development.

Module:1	Regression Analysis	6 hours

Linear regression: simple linear regression - Regression Modelling - Correlation, ANOVA, Forecasting, Autocorrelation

Module:2	Classification	6 hours

Logistic Regression, Decision Trees, Naïve Bayes-conditional probability - Random Forest - SVM Classifier

Module:3	Clustering	4 hours

K-means, K-medoids, Hierarchical clustering

Module:4	Optimization	3 hours

Gradient descent - Variants of gradient descent - Momentum - Adagrad - RMSprop - Adam - AMSGrad

Module:5	Managing Health and Safety	4 hours

Comply with organization's current health, safety and security policies and procedures - Report any identified breaches in health, safety, and security policies and procedures to the designated person - Identify and correct any hazards that they can deal with safely, competently and within the limits of their authority - Report any hazards that they are not competent to deal with to the relevant person in line with organizational procedures and warn other people who may be affected.

Module:6	Data and Information Management	4 hours

Establish and agree with appropriate people the data/information they need to provide, the formats in which they need to provide it, and when they need to provide it - Obtain the data/information

from reliable sources - Check that the data/information is accurate, complete and up-to-date		
Module:7	**Learning and Self Development**	**3 hours**
Obtain advice and guidance from appropriate people to develop their knowledge, skills and competence - Identify accurately the knowledge and skills they need for their job role - Identify accurately their current level of knowledge, skills and competence and any learning and development needs - Agree with appropriate people a plan of learning and development activities to address their learning needs		
	Total Lecture hours	**30 hours**

Text Book(s)

1. Cathy O'Neil and Rachel Schutt. "Doing Data Science, Straight talk from the Frontline", O'Reilly. 2014.
2. Dan Toomey, "R for Data Science", Packt Publishing, 2014.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman. "Elements of Statistical Learning", Springer , Second Edition. 2009.
4. Kevin P. Murphy. "Machine Learning: A Probabilistic Perspective", MIT Press; 1st Edition, 2012.

Reference Books

1. Glenn J. Myatt, "Making Sense of Data : A Practical Guide to Exploratory Data Analysis and Data Mining", John Wiley & Sons, Second Edition, 2014.
2. G. K. Gupta, ―Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.
3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
4. Colleen Mccue, "Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis", Elsevier, 2007.
5. R N Prasad, Seema Acharya, "Fundamentals of Business Analytics", Wiley; Second edition, 2016.
6. https://www.sscnasscom.com/qualification-pack/SSC/Q2101/

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

List of Challenging Experiments (Indicative)		
1.	Linear regression analysis	3 hours
2.	Forecasting - weather dataset using R	3 hours
3.	Gradient descend implementation using R	3 hours
4.	Text Analytics – Sentiment Analysis using R, Word cloud analysis using R	3 hours
5.	Time Series Components(Trend, Seasonality, Cyclicity and Level)	3 hours
6.	Banking Sector: Understand customer spend & repayment behavior, along with evaluating areas of bankruptcy, fraud, and collections. Also, respond to customer requests for help with proactive offers and service.	3 hours
7.	Retail Case Study: A retail store requires analyzing the day-to-day transactions and keeping a track of its customers spread across various locations and their purchases/returns across various categories. The objective of the case study is to understand customer behavior in-terms of purchase and returns through various Data Manipulation steps in R.	3 hours
8	Movie Recommendation System: To understand the functioning of how a recommendation system works. Develop an Item Based Collaborative Filter using Netflix dataset	3 hours

9.	Case study on Stock Market Analysis and applications. Stock data can be obtained from Yahoo! Finance, Google Finance. A team of students can apply statistical modeling on the stock data to uncover hidden patterns. R provides tools for moving averages, auto regression and time-series analysis which forms the crux of financial applications.	3 hours
10.	Detect credit card fraudulent transactions - The dataset can be obtained from Kaggle. The team will use a variety of machine learning algorithms that will be able to discern fraudulent from non-fraudulent one.	3 hours
	Total Laboratory Hours	**30 hours**
Mode of assessment: Assessment Examination, FAT Lab Examination		

Course Code	Information Security Analysis and Audit	L	T	P	J	C
CSE3501		2	0	2	4	4
Pre-requisite		Syllabus version				
		v.1.0				

Objective of the course

1. To introduce system security related incidents and insight on potential defenses, counter measures against common threat/vulnerabilities.
2. To provide the knowledge of installation, configuration and troubleshooting of information security devices.
3. To make students familiarize on the tools and common processes in information security audits and analysis of compromised systems.

Expected Outcome

After successfully completing the course the student should be able to

1. Contribute to managing information security
2. Co-ordinate responses to information security incidents
3. Contribute to information security audits
4. Support teams to prepare for and undergo information security audits
5. Maintain a healthy, safe and secure working environment
6. Provide data/information in standard formats
7. Develop knowledge, skills and competence in information security

1	**Information Security Fundamentals**	7 hours
Definitions & challenges of security, Attacks & services, Security policies, Security Controls, Access control structures, Cryptography, Deception, Ethical Hacking, Firewalls, Identify and Access Management (IdAM).		
2	**System Security**	6 hours
System Vulnerabilities, Network Security Systems, System Security, System Security Tools, Web Security, Application Security, Intrusion Detection Systems.		
3	**Information Security Management**	3 hours
Monitor systems and apply controls, security assessment using automated tools, backups of security devices, Performance Analysis, Root cause analysis and Resolution, Information Security Policies, Procedures, Standards and Guidelines		
4	**Incident Management**	5 hours
Security requirements, Risk Management, Risk Assessment, Security incident management, third party security management, Incident Components, Roles.		
5	**Incident Response**	4 hours
Incident Response Lifecycle, Record, classify and prioritize information security incidents using standard templates and tools, Responses to information security incidents, Vulnerability Assessment, Incident Analysis		
6	**Conducting Security Audits**	3 hours
Common issues in audit tasks and how to deal with these, Different systems and structures that may need information security audits and how they operate, including: servers and storage devices, infrastructure and networks , application hosting and content management, communication routes such as messaging, Features, configuration and specifications of information security systems and devices and associated processes and architecture, Common audit techniques, Record and report audit tasks, Methods and techniques for testing compliance.		
7	**Information Security Audit Preparation**	2 hours
Establish the nature and scope of information security audits, Roles and responsibilities, Identify the procedures/guidelines/checklists, Identify the requirements of information security, audits and prepare for audits in advance, Liaise with appropriate people to gather data/information required for information security audits.		
8	**Self and Work Management**	2 hours
Establish and agree work requirements with appropriate people, Keep the immediate work area clean and tidy, utilize time effectively, Use resources correctly and efficiently, Treat confidential information correctly, Work in line with organization's policies and procedures, Work within the limits of their job role.		

	Total Lecture hours:	**30 hours**

Text Book(s)

1. William Stallings, Lawrie Brown, Computer Security: Principles and Practice, 3rd edition, 2014.
2. Nina Godbole, Information Systems Security: Security Management, Metrics, Frameworks and Best Practices, Wiley, 2017
3. Nina Godbole, Sunit Belapure, Cyber Security- Understanding cyber-crimes, computer forensics and legal perspectives, Wiley Publications, 2016
4. Andrew Vladimirov Michajlowski, Konstantin, Andrew A. Vladimirov, Konstantin V. Gavrilenko, Assessing Information Security: Strategies, Tactics, Logic and Framework, IT Governance Ltd, O'Reilly, 2010

Reference Books

1. Charles P. Pfleeger, Security in Computing, 4th Edition, Pearson, 2009.
2. Christopher J. Alberts, Audrey J. Dorofee , Managing Information Security Risks, Addison-Wesley Professional, 2004
3. Peter Zor, The Art of Computer Virus Research and Defense, Pearson Education Ltd, 2005
4. Lee Allen, Kevin Cardwell, Advanced Penetration Testing for Highly-Secured Environments - Second Edition, PACKT Publishers, 2016
5. Chuck Easttom , System Forensics Investigation and Response, Second Edition, Jones & Bartlett Learning, 2014
6. David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni, Metasploit The Penetration Tester's
7 Guide, No Starch Press, 2014
8. Practical Malware Analysis by Michael Sikorski and Andrew Honig, No Starch Press, 2015
9. Ref Links:
   https://www.iso.org/isoiec-27001-information-security.html
   https://csrc.nist.gov/publications/detail/sp/800-55/rev-1/final
   https://www.sans.org/reading-room/whitepapers/threats/paper/34180
   https://www.sscnasscom.com/qualification-pack/SSC/Q0901/

List of Experiments (Indicative)

- Install and configure information security devices
- Security assessment of information security systems using automated tools.
- Vulnerability Identification and Prioritization
- Working with Exploits
- Password Cracking
- Web Application Security Configuration
- Patch Management
- Bypassing Antivirus Software
- Static Malware Analysis
- Dynamic Malware Analysis
- Penetration Testing
- MySQL SQL Injection
- Risk Assessment
- Information security incident Management
- Exhibit Security Analyst Role

Total Laboratory Hours	**30 hours**

Course Code	Information Security Management	L	T	P	J	C
CSE3502		2	0	2	4	4
Pre-requisite		Syllabus version				
		v.1.0				

Objective of the course

1. To introduce system security related incidents and insight on potential defenses, counter measures against common threat/vulnerabilities.
2. To provide the knowledge of installation, configuration and troubleshooting of information security devices.
3. To make students familiarize on the tools and common processes in information security audits and analysis of compromised systems.

Expected Outcome

After successfully completing the course the student should be able to

1. Contribute to managing information security
2. Co-ordinate responses to information security incidents
3. Contribute to information security audits
4. Support teams to prepare for and undergo information security audits
5. Maintain a healthy, safe and secure working environment
6. Provide data/information in standard formats
7. Develop knowledge, skills and competence in information security

1	**Information Security Devices**	5 hours
Identify And Access Management (IdAM), Networks (Wired And Wireless) Devices, Endpoints/Edge Devices, Storage Devices, Servers, Infrastructure Devices (e.g. Routers, Firewall Services) , Computer Assets, Servers And Storage Networks, Content management, IDS/IPS		
2	**Security Device Management**	6 hours
Different types of information security devices and their functions, Technical and configuration specifications, architecture concepts and design patterns and how these contribute to the security of design and devices.		
3	**Device Configuration**	5 hours
Common issues in installing or configuring information security devices, Methods to resolve these issues, Methods of testing installed/configured information security devices,		
4	**Information Security Audit Preparation**	5 hours
Establish the nature and scope of information security audits, Roles and responsibilities, Identify the procedures/guidelines/checklists, Identify the requirements of information security, audits and prepare for audits in advance, Liaise with appropriate people to gather data/information required for information security audits. **Security Audit Review -** Organize data/information required for information security audits using standard templates and tools, Audit tasks, Reviews, Comply with the organization's policies, standards, procedures, guidelines and checklists, Disaster Recovery Plan		
5	**Team Work and Communication**	2 hours
Communicate with colleagues clearly, concisely and accurately , Work with colleagues to integrate their work effectively, Pass on essential information to colleagues in line with organizational requirements, Identify any problems they have working with colleagues and take the initiative to solve these problems, Follow the organization's policies and procedures for working with colleagues		
6	**Managing Health and Safety**	2 hours
Comply with organization's current health, safety and security policies and procedures, Report any identified breaches in health, safety, and Security policies and procedures, Identify, report and correct any hazards, Organization's emergency procedures, Identify and recommend opportunities for improving health, safety, and security.		
7	**Data and Information Management**	3 hours

Fetching the data/information from reliable sources, Checking that the data/information is accurate, complete and up-to-date, Rule-based analysis of the data/information, Insert the data/information into the agreed formats, Reporting unresolved anomalies in the data/information.		
8	**Learning and Self Development**	2 hours
Identify accurately the knowledge and skills needed, Current level of knowledge, skills and competence and any learning and development needs, Plan of learning and development activities to address learning needs, Feedback from appropriate people, Review of knowledge, skills and competence regularly and appropriate action taken		

	Total Lecture hours:	**30 hours**

Text Book(s)

1. Information Systems Security: Security Management, Metrics, Frameworks and Best Practices, Nina Godbole, Wiley, 2017
2. Rhodes-Ousley, Mark. Information Security: The Complete Reference, Second Edition, . Information Security Management: Concepts and Practice. New York, McGraw-Hill, 2013.
3. Christopher J. Alberts, Audrey J. Dorofee , Managing Information Security Risks, Addison-Wesley Professional, 2004

Reference Books

1. Andrew Vladimirov Michajlowski, Konstantin, Andrew A. Vladimirov, Konstantin V. Gavrilenko, Assessing Information Security: Strategies, Tactics, Logic and Framework, IT Governance Ltd, O'Reilly 2010
2. Christopher J. Alberts, Audrey J. Dorofee , Managing Information Security Risks, Addison-Wesley Professional, 2004
3. Chuck Easttom , System Forensics Investigation and Response, Second Edition, Jones & Bartlett Learning, 2014
4. David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni, Metasploit The Penetration
5. Tester's Guide, No Starch Press, 2014

Ref Links:
https://www.iso.org/isoiec-27001-information-security.html
https://www.sans.org/reading-room/whitepapers/threats/paper/34180
https://csrc.nist.gov/publications/detail/sp/800-40/version-20/archive/2005-11-16
https://www.sscnasscom.com/qualification-pack/SSC/Q0901/

List of Experiments (Indicative)

1.
- Install and configure information security devices
- Penetration Testing
- MySQL SQL Injection
- Information security incident Management
- Intrusion Detection/Prevention
- Port Redirection and Tunneling
- Exploring the Metasploit Framework
- Working with Commercial Tools like HP Web Inspect and IBM AppScan etc.,
- Explore Open Source tools like sqlmap, Nessus, Nmap etc
- Documentation with Security Templates from ITIL
- Carry out backups of security devices and applications in line with information security policies, procedures and guidelines
- Information security audit Tasks - Procedures/guidelines/checklists for the audit tasks

Total Laboratory Hours	**30 hours**

Course Code	IoT Fundamentals	L	T	P	J	C
ECE3501		2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To impart knowledge on the infrastructure, sensor technologies and networking technologies of IoT.
2. To analyse, design and develop IoT solutions.
3. To explore the entrepreneurial aspect of the Internet of Things
4. To apply the concept of Internet of Things in the real world scenarios

Expected Course Outcome:

After successfully completing the course the student should be able to

1. Identify the main component of IoT
2. Program the controller and sensor as part of IoT
3. Assess different Internet of Things technologies and their applications

Module:1	Introduction	2 hours

IT-ITeS/BPM Industry – An Introduction, the relevance of the IT-ITeS sector, Future Skills – An Introduction, General overview of the Future Skills sub-sector

Module:2	Internet of Things - An Introduction	3 hours

Evolution of IoT and the trends, Impact of IoT on businesses and society, Existing IoT use cases and applications across industries.

Module:3	IoT Security and Privacy	6 hours

Security and privacy risks, analyze security risks, Technologies and methods that mitigate security, Privacy standards and regulations, Social and privacy impacts

Module:4	IoT Solutions	6 hours

IoT use case development, Need and Goals for IoT solution, Adoption of IoT solutions, Planning for IoT Solution: Evaluate costs, competition, technology challenges and internal resource considerations, Need for stakeholder buy-in

Module:5	Prototyping the Pilot execution	5 hours

Prototype developing Stages, deploy real-time UI/UX visualizations, Methods and metrics to analyze and convey business outcomes, feedback and data obtained from execution.

Module:6	Scalability of IoT Solutions	5 hours

Roadmap for developing complete IoT solutions, Strategies for implementation, key Milestone, Scalability of IoT Solutions, Methods, platforms and tools. Web and Mobile Interfaces

Module:7	Build and Maintain Relationships at the Workplace, Team Empowerment	3 hours

Total Lecture hours	30 hours

Text Book(s)

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A hands-on Approach”, University Press, 2015.
2. Adrian McEwen & Hakim Cassimally, “Designing the Internet of Things”, Wiley,Nov 2013, (1 st edition)

3. Claire Rowland, Elizabeth Goodman, Martin Charlier, Ann Light, Algred Lui," Designing Connected Products: UX for the consumer internet of things", O'Reilly, (1 st edition),2015

Reference Books

1. Rethinking the Internet of things: A Scalable Approach to Connecting Everything by Francis daCosta, Apress, 2014
2. Learning Internet of Things by Peter Waher, Packt Publishing, 2015
3. Designing the Internet of Things, by Adrian Mcewen, Hakin Cassimally , Wiley India Private Limited
4. Cloud Computing, Thomas Erl, Pearson Education, 2014
5. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, William Stallings, Addison-Wesley Professional; 1 edition
6. https://nsdcindia.org/sites/default/files/MC_SSCQ8210_V1.0_IoT-Domain%20Specialist_09.04.2019.pdf

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

List of Challenging Experiments (Indicative)	
1. Measure the light intensity in the room and output data to the web API.	3 hours
2. Control your home power outlet from anywhere using raspberry pi.	3 hours
3. Build a web based application to automate door that unlocks itself using facial recognition.	3 hours
4. Drinking water monitoring and analytics, consists of IoT device, cloud, and mobile and web app.	3 hours
5. Smart Parking System	3 hours
6. IoT based Healthcare application	3 hours
7. Real-time environmental monitoring and weather prediction	3 hours
8. Traffic pattern prediction	3 hours
9. Smart Street light	3 hours
10. Plant health monitoring	3 hours
Total Laboratory Hours	**30 hours**

Mode of assessment: Assessment Examination, FAT Lab Examination

Course Code	IoT Domain Analyst	L	T	P	J	C
ECE3502		2	0	2	4	4
Pre-requisite		Syllabus version				
		v.1.0				

Course Objectives:

1. To impart knowledge on the infrastructure, sensor technologies and networking technologies of IoT.
2. To analyse, design and develop IoT solutions.
3. To explore the entrepreneurial aspect of the Internet of Things
4. To apply the concept of Internet of Things in the real world scenarios

Expected Course Outcome:

After successfully completing the course the student should be able to

1. Identify the main component of IoT
2. Program the controller and sensor as part of IoT
3. Assess different Internet of Things technologies and their applications

Module:1	**IoT Solution Models**	**3 hour**

Models applied in IoT solutions, Semantic models for data models, Application of semantic models, information models, information models to structure data, relationships between data categories.

Module:2	**Data Models**	**3 hours**

Tags to organize data, tag data to pre-process large datasets, predictive models for forecasting, Application of predictive models.

Module:3	**Simulation Scenarios**	**4 hours**

Models to simulate real-world scenarios, Application of the models, stages of data lifecycle, reuse existing IoT solutions, reusability plan.

Module:4	**Use Case Development**	**4 hours**

Approaches to gather business requirements, defining problem statements, business requirements for use case development, Assets for development of IoT solutions.

Module:5	**Value engineering and Analysis**	**4 hours**

Principles and phases of Value Engineering and Analysis, Frameworks for Value Engineering in IoT solutions, cost-function analysis of IoT solution components, action plans to incorporate Value Engineering, Data modelling requirements, Development models: Waterfall, Agile, Spiral, V models, monetization models for IoT use cases - 'Outcomes As A Service' model.

Module:6	**Data Analytics for IoT Solutions:**	**6 hours**

Data generation, Data gathering, Data Pre-processing, data analyzation, application of analytics, vertical-specific algorithms, Exploratory Data Analysis.

Module:7	**Deployment of Analytics Solutions**	**6 hours**

Anomaly Detection and Data Clustering, Predictive Analytics and Streaming Analytics, cloud/edge methods, integrating analytics models, performance of analytical models, Templates for data insights, deriving insights.

Total Lecture hours:	**30 hours**

Text Book(s)

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A hands-on Approach”, University Press, 2015.
2. Adrian McEwen & Hakim Cassimally, “Designing the Internet of Things”, Wiley,Nov 2013, (1 st edition)
3. Claire Rowland, Elizabeth Goodman, Martin Charlier, Ann Light, Algred Lui,” Designing Connected Products: UX for the consumer internet of things”, O’Reilly, (1 st edition),2015

Reference Books

1. Rethinking the Internet of things: A Scalable Approach to Connecting Everything by Francis daCosta, Apress, 2014
2. Learning Internet of Things by Peter Waher, Packt Publishing, 2015
3. Designing the Internet of Things, by Adrian Mcewen, Hakin Cassimally , Wiley India Private Limited
4. Cloud Computing, Thomas Erl, Pearson Education, 2014
5. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, William Stallings, Addison-Wesley Professional; 1 edition
6.https://nsdcindia.org/sites/default/files/MC_SSCQ8210_V1.0_IoT-Domain%20Specialist_09.04.2019.pdf

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

List of Challenging Experiments (Indicative)	
1.Measure the light intensity in the room and output data to the web API.	3 hours
2.Control your home power outlet from anywhere using raspberry pi.	3 hours
3.Build a web based application to automate door that unlocks itself using facial recognition.	3 hours
4.Drinking water monitoring and analytics, consists of IoT device, cloud, and mobile and web app.	3 hours
5.Smart Parking System	3 hours
6.IoT based Healthcare application	3 hours
7.Real-time environmental monitoring and weather prediction	3 hours
8.Traffic pattern prediction	3 hours
9.Smart Street light	3 hours
10. Plant health monitoring	3 hours
Total Laboratory Hours	**30 hours**

Mode of assessment: Assessment Examination, FAT Lab Examination

Course Code	SIMULATION AND MODELING	L	T	P	J	C
CSE3102		2	0	2	0	3
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. Understand, classify and analyze kinematics, mobile dynamics in robots
2. Visualize, plan and simulate Paths and trajectories
3. Simulate robot rotation and revolution
4. Simulate robot environment and its dynamics

Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend, classify and analyze the fundamentals of kinematics
2. Understand the basics of motion planning and trajectory planning
3. Gain the knowledge about the concepts of dynamics and motion control of Rigid Body Simulation
4. Elucidate the construction and working of mobile robot dynamics and control
5. Build mobile robot simulation and its environments

Module:1	**Kinematic Models**	**5 hours**
Mobile Robots with Kinematic Constraints, Ackermann Kinematics, Unicycle Kinematic Model, Bicycle Kinematic Model, Differential Drive Kinematic Model, Inverse Kinematics		
Module:2	**Motion Planning**	**6 hours**
Visualizing robot workspace , 2-D occupancy map, Binary Occupancy Grids, Collision mesh simulation, Path planning with different complexities, Constraint oriented target simulation		
Module:3	**Trajectory Planning**	**3 hours**
Trajectory Simulation, Interactive simulation, Probabilistic Roadmaps (PRM)		
Module:4	**Rigid Body Simulation**	**4 hours**
Rigid Body Simulation, Rigid Body Joints, Rigid Body Tree, Task Space Motion Model		
Module:5	**Dynamics and Motion Control**	**6 hours**
3D rotations and Orientations: Quaternion, Matrix representation of Quaternion, Euler Angles, Looping at a fixed frequency, Euler angles for Homogenous and Heterogeneous Transformations		
Module:6	**Mobile Robots and its Environment Simulation**	**4 hours**
Obstacle avoidance Robot, Path following differential drive robot, Robot to track an object		
Module:7	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. M.W. Spong, S. Hutchinson and M. Vidyasagar, Robot Modeling and Control, 2nd Edition, JOHN WILEY & SONS, INC, 2020.
2. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Robotics: Modelling, Planning and Control, Springer Publishing Company, 2008

Reference Books

1.	Daniel L. Ryan, Robotic Simulation, First Edition, CRC Press, 1993.	
2.	John Brown, Robot Simulation and Programming: From Simulation to Real World Implementation, E-book Edition, 2018	
3.	https://in.mathworks.com/products/robotics.html ece	
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).		
List of Challenging Experiments (Indicative)		
1	**Environment Simulation** Simulate different environments of robotic applications	4 hours
2	**Path Following for a Differential Drive Robot** Demonstrates how to control a robot to follow a desired path using a Robot Simulator	4 hours
3	**Path Planning in Environments of Different Complexity** Demonstrate how to compute obstacle free path between two locations	4 hours
4	**Simulate a Mobile Robot in a Warehouse Using Gazebo** simulate a warehouse robot in Gazebo	4 hours
5	**Track a car-like robot using particle filter** Simulate particle filter based object tracking	4 hours
6	**Simulate Different Kinematic Models for Mobile Robots** Model different robot kinematics models in an environment and compare them	5 hours
7	**Control a Differential Drive Robot in Gazebo** Control a robot that follows a set of waypoints by reading the pose and wheel encoder positions and generates torque-control commands to drive it	5 hours
	Total Laboratory Hours	**30 hours**
Mode of Evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT).		

Course Code	FUNDAMENTALS OF AUTONOMOUS SYSTEMS	L	T	P	J	C
CSE2038		3	0	0	0	3
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. To provide basics of human autonomous systems.
2. To impart the knowledge basic structure and layers of autonomous systems.
3. To develop a deeper understanding architecture and interpretation system..
4. To provide knowledge distributed autonomous systems.

Course Outcomes:

1. Differentiate systems, agents and issues in modelling autonomous systems.
2. Validate the concepts of basic structure and types of artificial orgrnas.
3. Analyse the effect of influence of layers of autonomous systems with agentification.
4. Explain the role of interpreting systems and behavioural learning.
5. Understand the current representations and tendencies of autonomous systems.
6. Understand the concepts of scale downed autonomous systems.
7. Explain the autonomy of distributed autonomous systems.

Module:1	Introduction to Autonomous Systems	5 hours

Conventional systems, Complex systems, System of systems; Autonomous systems; Agents and multi-agent systems; Systems and organisms; Issues in modeling an autonomous system.

Module:2	Architecture of an Autonomous System	7 hours

Reactivity of a system; Basic structure of an autonomous system; The membrane of autonomous systems; Two types of proactivity and the notion of artificial organ; Autonomy and current representation in an autonomous system; The unifying system that generates representations.

Module:3	Layers of Multi-agent Autonomous System	7 hours

Object layer on the substratum; Agent representation of the substratum; Interpretation system and the conception agents; Aggregates, intent and the activity of conception agents; Agentifying conception agents; Activity of a conception agent; Three layers of conceptual agentification; Semantic lattices and the emergence of representations in the interpretation system;

Module:4	Architecture of Multi-agent Autonomous System	7 hours

General architecture of the interpretation system; Agentification of knowledge and organizational memory; Setting up the membrane network of an autonomous system; Behavioral learning of the autonomous system.

Module:5	Generation of Current Representation and Tendencies	7 hours

Generation of current representation and semantic lattices; Cause leading the system to choose a concrete intent; Presentation of artificial tendencies; Algorithm for the generation of a stream of representations under tendencies.

Module:6	Towards the Minimal Self of an Autonomous System	6 hours

Needs and desires of the autonomous system; A scaled-down autonomous system; The internal choice of expressed tendencies and the minimal self; Incentive to produce representations; Minimal self-affectivity: emotions and sensations; Algorithms for tendency activation; The feeling of generating representations.

Module:7	Global Autonomy of Distributed Autonomous Systems	4 hours

Enhancement of an autonomous system by itself; Communication among autonomous systems in view of their union; Autonomous meta-system composed of autonomous systems; System generating autonomous systems: the meta-level of artificial living.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Alain Cardon, Mhamed Itmi, New Autonomous Systems, Wiley-ISTE- 2016
2.	Nikolaus Correll, Introduction to Autonomous Robots, Magellan Scientific, 2016
Reference Books	
1.	Jitendra R. Raol, Ajith K. Gopal, "Mobile Intelligent Autonomous Systems" CRC Press, 2017.

Mode of Evaluation: Continuous Assessment Test –I, Continuous Assessment Test –II, Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test.

Course code	FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE	L	T	P	J	C
CSE2039		2	0	2	4	4
Pre-requisite	-	Syllabus version				
		v. 1.0				

Course Objectives:

1. Familiarize students with Artificial Intelligence principles and techniques
2. Introduce the facts of computational model and their applications
3. Explore problem-solving paradigms, search methodologies
4. Introduce the learning algorithms and the current trends

Course Outcome:

1. Characterize different types of AI environments, transform a given real world problem to state space problem, understand and identify the stages and issues in the development expert system
2. Apply different searching algorithms and heuristic methodologies to reach the goal in state-space problems.
3. Formulate a given real world problem formally using different knowledge representation methods and draw inferences from it.
4. Implement appropriate searching strategies for few real world environments
5. Understand learning concepts and learning from outcomes

Module:1	Introduction	6 hours

Definitions - Importance of AI, Evolution of AI - Applications of AI, Classification of AI systemswith respect to environment, Intelligent Agents, Different types of agents
Learning From Data – Concept Learning – Learning from Outcomes - Supervised Vs Unsupervised Machine Learning

Module:2	Problem solving	7 hours

Problem solving by Search, Problem space - State space, Blind Search - Types, Performance measurement - Informed search strategies, Heuristic functions, Local search strategies- Hill climbing, simulated annealing.

Module:3	Adversarial Search	3 hours

Game playing – mini-max algorithm, Alpha-Beta Pruning.

Module:4	Logical systems	5 hours

Knowledge Based systems, Propositional Logic, First Order Logic -Representation, Syntax and semantics, quantifiers, Inference in First Order Logic. Resolution- Horn clauses, Forward chaining and backward chaining

Module:5	Uncertainiy and Knowledge Reasoning	3 hours

Definition of uncertainty, Bayes Rule – Inference, Belief Network.

Module:6	Machine Learning	4 hours

Naive Baye's classifier Hidden Markov models, Decision trees, K-Means Clustering, Neural Networks – Ensemble Methods – Boosting Approaches

Module:7	Contemporary Topics	2 hours

	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Stuart Russell and Peter Norvig Artificial Intelligence - A Modern Approach, PrenticeHall, 3rd edition, 2016.	
2.	D. Poole and A. Mackworth. Artificial Intelligence: Foundations of Computational Agents,Cambridge University Press, 2010	
Reference Books		
3.	Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Education (India) 2013	
4.	Elaine Ric, Kevin Knight and Shiv Shankar B. Nair, Artificial Intelligence, 3rd edition, Tata McGraw Hill, 2009.	
5.	George F. Luger, "Artificial Intelligence-Structures and Strategies for Complex Problem Solving", 6th edition, Pearson, 2008.	
6.	R. Brachman, H. Levesque. Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.	
7.	E. Alpaydin. Introduction to Machine Learning. MIT Press, 2nd edition, 2010	
8.	R. S. Sutton and A. G. Barto. Reinforcement Learning: An Introduction. MIT Press, 1998	
9.	N.P.Padhy: Artificial Intelligence and Intelligent Systems, Oxford University Press, 2009.	
Mode of Evaluation: Continuous Assessment Test –I, Continuous Assessment Test –II, Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test.		
List of Challenging Experiments (Indicative)		
1.	BFS	2 hours
2.	Uniform cost search	2 hours
3.	DFS	2 hours
4.	Depth limited search	2 hours
5.	A* algorithm implementation	2 hours
6.	Getting acquainted with Prolog	10 hours
7.	Machine Learning Approaches	10 hours
	Total Laboratory Hours	30 hours
Mode of Evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT).		
Project		
1. Game Programming 2.Logical Reasoner 3.Path Planner 4.Causal Analysis Using BayesNetwork 5.Naive Bayes Classification 6.K-Means Clustering 7.Decision Trees		
Mode of evaluation: Review I, II and III.		

Course Code	ROBOTS, BOTS AND COMMUNICATION	L	T	P	J	C
CSE3101		2	0	2	4	4
Pre-requisite	CSE1004, CSE1022	Syllabus Version				
		1.0				

Course Objectives:

1. Learn and understand the basic concepts, history, evolution and anatomy of Bots and its applications.
2. To know the difference between robots, bots and robotic process automation.
3. Understand the various communication protocols used in Industrial robots.

Course Outcomes:

After the completion of the course, student will be able to:

1. To understand the difference between robots, bots and robotic process automation.
2. Learn and understand the basic concepts of Bots and its applications
3. Understand the history, evolution and anatomy of bots.
4. To understand how to plan, implement, test, and deploy bots
5. Understand the various communication protocols used in Industrial robots

Module:1	Introduction	4 hours

Bots, Difference between bots and RPA, The Bot Revolution and Evolution, Stages of Bot adoption, Bot Types – Personal Vs Team Bots, Super Bots Vs Domain Specific Bots, Business Bots Vs Consumer Bots, Voice Vs Text Bots, Net New Bots Vs Integrations Exposing Legacy Systems.

Module:2	Major Platforms	4 hours

The Business Bot Platform: Slack, The Consumer Bot Platform: Facebook Messenger, The Voice Bot Platform: Alexa, The Teens' Bot Platform: Kik, The Legacy Bot Platforms: Email, SMS, How to Choose a Platform

Module:3	Bot Anatomy	5 hours

Bot Anatomy – Breaking Down Bots – Core Purpose and Functionality, Branding, Personality, and Human Involvement: Branding – Visual Branding, Logo, Stickers, Images, Naming; Personality – WordsBot, Poncho, Expressing Your Personality; Human Intervention

Module:4	Conversation	5 hours

Onboarding, Functionality Scripting, Decoration, Acknowledgment and Confirmation, Consistency, Reciprocity, Team Versus Private Interactions, Error Handling - Course Correction, Human Intervention, Restarting the Conversation, Redirecting to Another Bot, Keeping It Consistent, Learning from Your Bot's Mistakes, Help and Feedback

Module:5	Designing and Testing	4 hours

Designing a Bot with Botsociety, User Testing - Prototyping a Mockup Bot, Planning the Test, Creating Tasks and Discussion Guides, Recruiting Participants, Setting Up the Environment, Moderating the Sessions, Analyzing the Data, Improving and Iterating.

Module:6	Bot Building Overview	3 hours

Bot Architecture, Bot Building Technologies – Visual Authoring Tools and Integrated Development

Environments (IDEs), Artificial Intelligence (AI) Services, Software Development Kits and Bot Frameworks, Picking the Right Tool.		
Module:7	**Introduction to Communication Protocols**	**3 hours**
ControlNet, EtherNet/IP, DeviceNet, TSN, Flexray		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Amir Shevat, Designing Bots: Creating Conversational Experiences, O'Reilly, 2017
2.	Deon Reynders, Steve Mackay, Edwin Wright, Practical Industrial Data Communications, 1st Edition ELSEVIER, 2005
Reference Books	
1.	Craig J.J., Introduction to Robotics Mechanics and Control, Pearson Education, 2008.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

List of Challenging Experiments (Indicative)

1	Google Apps Script bot, Simple Automation	6 hours
2	Build a Google Chat bot with Google Cloud Functions	6 hours
3	Conversational AI for messaging apps	6 hours
4	Voice based chatbots	6 hours
5	Bots to find the customer feedback	6 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT).

Typical Projects

1. Bots to book tickets to Events/Shows
2. Use Chatbots to find products, check inventory and recommend items
3. Bots to build remarkable customer experience
4. Bots to process return and exchange requests
5. Bots to confirm orders and track shipping
6. Bots as personal shopping assistants
7. Bots as sales agents
8. Bots provide quotes and estimates

Mode of evaluation: Review I, II and III.

Course code	HUMAN – ROBOT INTERACTION	L	T	P	J	C
CSE3114		3	0	0	0	3
Pre-requisite	-	Syllabus version				
		v. 01				

Course Objectives

1. To provide basic concepts and issues of human robot interaction.
2. To impart the knowledge of multifaceted nature of trust in HRI
3. To develop a deeper understanding multi modal interface, standards and regulations.
4. To provide knowledge about performance measurements and robot & human safety.

Course Outcome

1. Differentiate types, methods and challenges of human robot interaction.
2. Validate the concepts, unique features, multifaceted nature of trust in HRI.
3. Analyse the effect of influential factors, determinants, prediction perspectives and antecedents of trust.
4. Explain the standards and regulations.
5. Understand the role of ethics of autonomous robots.
6. Understand the role of techniques and methods to estimate the performance and hindrances.
7. Explain the need of various criteria for the safety of humans and robots.

Module:1	Human Factors and Ergonomics Methods.	5 hours

Definitions, Six Methods, Wilson's Five Basic Types of Design Data, Other Methods Challenges for Human Factors and Ergonomics Methods.

Module:2	Multifaceted nature of trust in HRI.	5 hours

Multidimensional concepts and measures, recent concepts and evaluations used in HRI, unique features of trust in intelligent autonomous systems.

Module:3	Various influential factors that have known to affect trust in HRI.	7 hours

Influential factors that have known to affect trust in HRI, list of determinants of trust in HRI from the modelling, measurement, and prediction perspectives. Individual and social determinants of trust. Currently identified antecedents of trust.

Module:4	Standards and Regulations.	7 hours

Role of standardization in technical regulations. Relationship between private standards and public policy making. Standard ontologies. Robot safety benchmarking and standards. ISO 13482 reference.

Module:5	Ethics of Autonomous Robots	7 hours

AI & Robotics. Privacy & Surveillance. Opacity of AI systems. Automation and employment. Machine ethics. Artificial moral agents. Singularity and superintelligence.

Module:6	Performance measurements	7 hours

Crandall's Neglect Tolerance model, Simultaneous measurements of body motion and electromyograms to assess biophysical information. Handedness as an important factor in designing tools and devices that are to be handled by people using their hands. Cueing capabilities facilitate multitasking

Module:7	Robot & Human safety	5 hours

Safety and reliability of robotic systems. Six severity level design (SSLD). Effective hazard assessment and control. Safety of robotic work zones - intelligent safety sensors. Acceptable safety criteria for the robot implementations.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Neville Stanton, Alan Hedge, Karel Brookhuis, Eduardo Salas, Hal Hendrick.Handbook of Human Factors and Ergonomics Methods, CRC Press, 2004.
2.	Vladimir A. Kulyukin, Advances in Human-Robot Interaction, IntechOpen, 2009.
3.	Chang S. Nam, Joseph B. Lyons, Trust in Human Robot Interaction, Academic Press, 2021.
Reference Books	
1.	Mansour Rahimi, Waldemar Karwowski, Human-Robot Interaction, Taylor & Francis, 2004.
2.	Martin Helander, A guide to human factors and ergonomics, Taylor & Francis Group, 2005.
3.	Paolo Barattini, Federico Vicentini, Gurvinder Singh Virk, and Tamás Haidegger. Human–Robot Interaction Safety, Standardization, and Benchmarking, Taylor & Francis, 2019.

Course Code	MACHINE LEARNING AND ITS APPLICATIONS	L	T	P	J	C
CSE 3105		2	0	2	4	4
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. To teach the theoretical foundations of various learning algorithms
2. To understand the context of supervised and unsupervised learning through practical experiences
3. Apply all learning algorithms over appropriate real-time dataset collected through robotic sensors
4. Evaluate the algorithms based on corresponding metrics identified

Course Outcomes:

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

1. Understand, visualize and analyze the collected data from a real-time source.
2. Prepare the data to suit for processing with Machine learning algorithms.
3. Apply appropriate algorithm depending on the type of data and application.
4. Measure the results of algorithm and perform necessary analysis.
5. Convert the results to appropriate information required for the real – time application.

Module:1	Introduction to Machine Learning	3 hours

Introduction – Exploration of when, why and how to apply ML – The learning Problem – Basic terminologies – Categories – Datasets – Choosing appropriate category of ML algorithm

Module:2	Data Preprocessing	3 hours

Missing Value Analysis – Values Imputation – Correlation Analysis – Outlier Analysis – Learning curves – Class Imbalance – Underfitting – Overfitting.

Module:3	Supervised Learning – I	5 hours

Linear and Non-Linear examples – Multi–Class & Multi-Label classification – Linear Regression – Multilinear Regression – Naïve Bayes Classifier – Decision Trees – ID3 – CART – Error bounds, – case studies.

Module:4	Supervised Learning – II	4 hours

Logistic Regression – Mapping with Linear regression — Maximum Margin – Support Vector Machines – Linear SVM – Soft Margin – Metrics for measurement – case studies.

Module:5	Perceptron	4 hours

Activation function – Learning rate – Single Layer Perceptron – Multi Layer Perceptron – Adjusting nodes and layers – case studies.

Module:6	Ensemble Learning	4 hours

Bagging and Boosting (Random forests, Adaboost, XG boost inclusive) – case studies.

Module:7	Unsupervised Learning	5 hours

Clustering basics (Partitioned, Hierarchical and Density based) - K-Means clustering – K-Mode clustering – Self organizing maps – Principal Component Analysis – case studies.

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

Text Book(s)

1.	Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.
2.	**Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2012.**
3.	**Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition,1997.**
4.	Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.
5.	Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer 2011 Edition.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Lab (Indicative procedure)

1 **Software requirement (Optional as per student's convenience):**
Python, Numpy, Tensorflow, Keras, Pandas, OpenCV

List of experiments:

Appropriate datasets from the following repository (suggestive) can be taken. Datasets to be pre-processed, implemented and error analysis and visualization to be done.

1. https://archive.ics.uci.edu/ml/datasets.html
2. http://sci2s.ugr.es/keel/datasets.php#sub1

Algorithms to be practised include,

1. Linear & Multi-Linear Regression
2. Naïve Bayes classifier
3. Decision trees – ID3 & CART
4. Logistic regression
5. Support Vector Machines – Linear & Non-linear
6. Single & Multilayer Perceptrons
7. K-NN, K-Means & K-mode clustering
8. Random – forest
9. Adaboost, XGboost
10. Self – Organizing maps

Total Laboratory Hours	**30 hours**

Mode of Evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT).

Typical Projects

Sample Projects:

1. Breast cancer detection system
2. Adaptive e-learning system
3. E-Recommendation system
4. Companion bots
5. Threat detection system

Mode of evaluation: Review I, II and III.

Course code	SOFT COMPUTING	L	T	P	J	C
CSE 3106		3	0	0	4	4
Pre-requisite	-	Syllabus version				
		v. 1.0				

Course Objectives

1. To introduce fundamental concepts of soft computing techniques.
2. To explain various architectures & algorithms of neural networks.
3. To learn fuzzy sets, fuzzy logic, rough sets and genetic algorithms.

Course Outcome

1. Analyze the given computational task for its appropriateness of applying soft computing techniques.
2. Apply soft computing techniques for practical applications.
3. Design a soft computing system required to address a computational task.

Module:1	Neural Nets	6 hours

Introduction to Soft computing, Neural Networks Role in soft computing, Adaline, Back-propagation network, Recurrent Neural Networks, RBF Networks.

Module:2	Memory Models	6 hours

Pattern Association, Auto Associative Memory Networks, Hetero Associative Memory Networks, Bidirectional Associative Memory, Hopfield networks, Iterative Associative Memory Networks, Temporal Associative Memory Networks.

Module:3	Unsupervised Networks	6 hours

Fixed Weight Competitive Nets, Learning Vector Quantization, Counter Propagation Networks, Adaptive Resonance Theory Networks.

Module:4	Other Networks	6 hours

Special Networks- Boltzmann Machines. Ensemble Neural Networks, Convolutional Networks, Deep Neural Networks, Extreme Learning Machines.

Module:5	Fuzzy Logic & Approximate Reasoning	7 hours

Introduction to Fuzzy Logic, Fuzzy sets and operations, Fuzzy relations, fuzzification & defuzzification. Fuzzy arithmetic and Fuzzy Measures. Fuzzy Propositions, Fuzzy Reasoning.

Module:6	Fuzzy Decision Making	6 hours

Fuzzy Inference System, Fuzzy controller, Individual decision making, multi-objective and multi-attribute decision making, Industrial applications.

Module:7	Search Strategies	6 hours

Basic concepts of search strategies, Genetic Algorithm working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, Applications

Module:8	Contemporary Topics	2 hours

	Total Lecture hours	45 hours

Text Book(s)	
1.	Principles of Soft Computing, 3rd Edition by Sivanandam & Deepa, Wiley India, 2018.
Reference Books	
1.	Introduction to Soft Computing, by Samir Roy and Udit Chakraborty, Pearson, 2013
2.	Fundamentals of Neural networks: architectures, algorithms and applications by Laurene Fausett, Pearson India, 2008
3.	Fuzzy logic with Engineering Applications, 3rd Edition by T.J. Ross, Wiley India, 2010
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).	
Typical Projects	
1. Generating Image Descriptions. 2. Robot path planning using SOM. 3. Hand gesture Recognition. 4. Fire and smoke detection robot. 5. Identifying weeds in field crops	
Mode of evaluation: Review I, II and III.	

Course code	CYBER SECURITY	L	T	P	J	C
CSE3111		3	0	0	0	3
Pre-requisite	-	Syllabus version				
		v1.0				

Course Objectives:

1. To learn the concepts of threat models, system vulnerabilities and possible attacks.
2. To understand data confidentiality, integrity, authentication process and access control.
3. To familiarize various cyber threats, attacks, vulnerabilities, defensive mechanisms, security, policies and practices for Computers and IoT devices.

Course Outcome:

1. Know the fundamental knowledge about cyber security, network and information security
2. Know how to protect the data using data confidentiality technique such as cryptographic algorithms
3. Comprehend the authenticated process, integrity, access control and its implementation
4. Know the analyzing process of security threats and vulnerabilities of the devices and systems using models and existence of intruders
5. Explore the security attacks and vulnerabilities in WSN and IoT and understand the importance of design an secure IoT devices

Module:1	Introduction	5 hours

Cyber Security, Information security and Network Security : Security objectives, challenges of Information security - Security attacks: passive and active - Security Services – Network security: communications security, device security – Legal and regulatory requirements : EU general data protection regulation

Module:2	Data Confidentiality	10 hours

Symmetric key cryptographic techniques: Introduction to Stream cipher, Block cipher: DES, AES,IDEA Asymmetric key cryptographic techniques: principles, RSA, ElGamal, Elliptic Curve cryptography, Key distribution and Key exchange protocols - Cryptographic Fundamentals for IoT Security Engineering

Module:3	Integrity, Authentication and Access Control	7 hours

Hash functions, Secure Hash Algorithm (SHA) Message Authentication, Message Authentication Code (MAC), Digital Signature Algorithm – Authorization – Access Control

Module:4	Threats and Intruders	7 hours

Threat Models: NIST threat models, Threat sources, Identifying threats – Malicious Software and Intruders: Nature of malware threats, malware protection software – Firewall – Intrusion Detection Systems

Module:5	Vulnerabilities and Attacks	8 hours

Wireless Sensor Networks – WSN security attacks: active, passive, internal and attacks - IoT – IoT Security and Attacks: Active and Passive – Secure Design of IoT Devices - Identity and Access Management Solutions for the IoT – Cloud Security for IoT Devices

Module:6	Cybersecurity Policies and Practices	4 hours

What security policies are: determining the policy needs, writing security policies, Internet andemail security policies, Compliance and Enforcement of policies, Review		
Module:7	**Recent Trends**	**2 hours**
Pegasus attacks – Zero click vulnerability and Zero day attacks – security vulnerabilities in smart cities		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Information privacy engineering and Privacy by design, William Stallings, 1st Edition, Addison-Wesley, 2019
2.	Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem, Brain Russell and Drew Van Duren, 2nd Edition, 2016
3.	Cryptography and Network security, William Stallings, Pearson Education, 7th Edition, 2016
4.	Cyber Security, Understanding cyber crimes, computer forensics and legal perspectives,Nina Godbole,Sunit Belapure, Wiley Publications, Reprint 2016
5.	Writing Information Security Policies, Scott Barman, New Riders Publications, 2002
Reference Books	
6.	Cybersecurity for Dummies, Brian Underdahl, Wiley, 2011
7.	Cryptography and Network security, Behrouz A. Forouzan , Debdeep Mukhopadhyay, Mcgraw Hill Education, 2 nd Edition, 2011

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Course Code	DIGITAL TWIN	L	T	P	J	C
CSE 3107		3	0	0	4	4
Pre-requisite	-	Syllabus Version 1.0				

Course Objectives:

1. To introduce and explain the concepts of Digital Twin
2. To understand the basic building blocks of Digital Twin
3. To have a clear knowledge about design and development and digital information mapping process
4. To familiarize students with the assessment plans and security risks associated with Digital Twin
5. To get knowledge about the real time applications of Digital Twin

Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend, classify and analyze the behavior of digital twins
2. Analyze the characteristics and basic building techniques of Digital twin
3. Gain the knowledge about the types of digital twins: their life cycle and its features
4. Elucidate the various concepts which acts as a backbone for Digital twin in various sectors
5. Design the digital twin based components in different industry sectors

Module:1	Introduction	4 hours

Definition – Basic Concepts of Digital Twin – Types of Digital Twin – Benefits, Impact and Challenges – Industry 4.0 Overview

Module:2	Building Blocks	6 hours

Digital Twin Building Blocks – Technology Drivers and Enablers – Enabling Technologies and Functional Blocks - IoT, IIoT, Data Analytics – Digital Model vs. Digital Shadow vs. Digital Twin – Business Building Blocks

Module:3	Design and Development	7 hours

Layered Architecture – Middleware – Characteristics of Digital Twin Platform – Adoption Strategy - Life Cycle of Digital Twin - Features and Implementations – Digital Twin Workflow – Interoperability

Module:4	Digital Information Mapping	8 hours

Digital Twin Framework – GENIX – DT Manufacturing Framework – IoT DT Framework – DT OpenSource Frameworks – Connectivity – Digital Twin Network(DTN)– Benefits – DT in Mobile Networks

Module:5	Assessment Plans	6 hours

Criteria for Project Management – Scope and Requirements management Plan – Work Breakdown and Resource Breakdown Structure(WBS, RBS) – Risk audit and Management Plan – Variance Analysis – Quality management and Metrics

Module:6	Security	5 hours

Security Risks – Risk Mitigation Plans – Cyber security and trustworthiness – Security Benefits of Digital Twin – Digital Twin Security Integration techniques

Module:7	**Applications**	**7 hours**
Condition monitoring – Predictive Maintenance, Product Life Cycle Management in digital twin, Introduction to Use Cases – HealthCare, Smart Cities, Manufacturing Domain, Automotive sector, Aerospace, Construction, Agriculture Domain.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1.	Anand Iyer, "Possibilities of the new Digital Twin Technology", Kindle Edition, Amazon India Pvt. Ltd., 2017.
2.	Gerard Blokdyk, "Digital Twin : Beginners Guide", Third Edition, Amazon India Pvt. Ltd, October 2017.
3.	Gerard Blokdyk, " Digital Twin : A Complete Guide", 2019 Edition, Amazon India Pvt. Ltd,

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Typical Projects

1. Utility based services like water supply
2. Virtual prototyping in healthcare
3. Build sophisticated models to analyze customer behavior
4. Autonomous delivery in logistics
5. Progress monitoring and resource planning in Real estate
6. Smart cities
7. Digital simulations in manufacturing

Mode of evaluation: Review I, II and III.

Course code	BLOCKCHAIN TECHNOLOGY	L	T	P	J	C
CSE 3108		2	0	2	0	3
Pre-requisite	-	Syllabus version				
		v.1				

Course Objectives

1.To provide knowledge about fundamental concepts of block chain
2. To understand the building blocks of blockchain
3. To provide basic insights on various block chain use cases

Course Outcome

1. Understanding purpose and importance of block chains
2. Fundamentals of decentralization systems
3. Understanding of real time simple block chains components
4. Understanding of various real time use cases and the allied technologies

Module:1	Introduction	5 hours

Introduction, Concept of Blockchain, History, Definition of Blockchain, Fundamentals of Blockchain, Characteristics of Blockchain, Consensus in Trust-Building Exercise, Public, Private, and Hybrid Blockchains, Distributed Ledger Technologies, DLT Decentralized Applications and Databases, Architecture of Blockchain, Transactions, Chaining Blocks, Value Proposition of Blockchain Technology

Module:2	Decentralized System	4 hours

Distributed Decentralized Databases, Decentralized Enterprise, Decentralization, Decentralized Enterprise Regulation

Module:3	Hash Functions	5 hours

Hashing, Message Authentication Code, Secure Hash Algorithms (SHA-1), Secure Hash Algorithm Version 3, Distributed Hash Tables, Hashing and Data Structures, Hashing in Blockchain Mining

Module:4	Consensus	3 hours

Consensus Approach, Consensus Algorithms, Byzantine Agreement Methods

Module:5	Blockchain Components	5 hours

Ethereum, Ethereum Virtual Machine, Working of Ethereum, Ethereum Clients, Ethereum Key Pairs, Ethereum Addresses, Ethereum Wallets, Ethereum Transactions, Ethereum Development Tools

Module:6	Smart Contracts	3 hours

Smart Contracts, Absolute and Immutable, Contractual Confidentiality, Law Implementation and Settlement

Module:7	Use cases and Allied Technologies	3 hours

Use Cases – Healthcare, Assets Management, Electronic Currency, Manufacturing.
Blockchain and Allied Technologies - Blockchain and Cloud Computing, Blockchain and Artificial Intelligence, Blockchain and IoT, Blockchain and Machine Learning, Blockchain and Robotic Process Automation

Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Kumar Saurabh, Ashutosh Saxena, “Blockchain Technology: Concepts and Applications”, Wiley, 2020	
Reference books		
1.	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, “Bitcoin and Cryptocurrency Technologies”, Princeton University Press (July 19, 2016) ISBN-13: 978-0691171692.	
2.	Mukkamala, Raghava Rao, Ravi Vatrapu, Pradeep Kumar Ray, Gora Sengupta, and Sankar Halder. "Blockchain for Social Business: Principles and Applications." IEEE Engineering Management Review (2018).	
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).		
Indicative Experiments		
1.	Developing structure of block chains	
2.	Smart contracts	
3.	Working on ethereum platform	
4.	Real time experiments on ethereum	
5.	Developing separate applications on etherium platform	
	Total Laboratory Hours	30 hours

Course code	CLOUD COMPUTING	L	T	P	J	C
CSE 3109		2	0	2	4	4
Pre-requisite	-	Syllabus version				
		V 1.0				

Course Objectives:

1. To introduce the cloud computing concepts and map reduce programming model.
2. To provide skills and knowledge about operations and management in cloud technologies so as to implement large scale systems.
3. To provide skills to design suitable cloud infrastructure that meets the business services and customer needs.

Expected Course Outcome:

1. Understand the models, principles, and benefits of Cloud Computing in order to assess existing cloud infrastructures to choose an appropriate architecture that meets business needs.
2. Decide a suitable model to capture the business needs by interpreting different service delivery and deployment models.
3. Understand virtualization foundations to cater the needs of elasticity, portability and resilience by cloud service providers.
4. Infer Anatomy of the Cloud and to implement the cloudapplications using map reduce programming models.
5. Design a cloud framework with appropriate resource management techniques with its security.
6. Compare operation and economic models of various trending cloud platforms prevailing in IT industry.

Module:1	Foundations of cloud	3 hours

Evolution of Cloud Computing – Cloud models-System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture – On-demand Provisioning – Elasticity in Cloud – deployment models – Service models-cloud service providers – Characteristics and – Challenges in Cloud computing- Service level agreements - Types of SLA – Lifecycle of SLA- SLA Management

Module:2	Cloud Resource Virtualization	4 hours

Basics of Virtualization - Types of Virtualization - Understanding Hypervisors - Implementation Levels of Virtualization -Virtualization Structures - Tools and Mechanisms – Resource sharing and Resource pooling -Desktop Virtualization – Server Virtualization.

Module:3	Cloud Computing Architecture and Management	5 hours

Cloud Computing Architecture and Management: Cloud architecture, Layer, Anatomy of the Cloud, Network Connectivity in Cloud Computing, Applications, on the Cloud, Managing the Cloud, Managing the Cloud Infrastructure Managing the Cloud application, Migrating Application to Cloud, Phases of Cloud Migration Approaches for Cloud Migration.

Module:4	Cloud Infrastructure and Programming Model	4 hours

Architectural Design of Compute and Storage Clouds – Layered Cloud Architecture Development – Design Challenges - Map Reduce, Twister and Iterative Map Reduce – Hadoop Library from Apache – Mapping Applications - Google File System

Module:5	**Resource Management and Scheduling in Cloud**	**4 hours**
Inter Cloud Resource Management – Resource Provisioning and Platform Deployment – Global Exchange of Cloud Resources - Resource Management and Dynamic Application Scaling - Scheduling Algorithms for Computing Clouds		
Module:6	**Advances is Cloud and Cloud Security**	**4 hours**
Media Clouds - Computing Clouds - Mobile Clouds – Security Overview – Cloud Security Challenges – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Virtual Machine Security		
Module:7	**Advances in Cloud Platforms and Application Development**	**4 hours**
Comparing Amazon web services, Google AppEngine, Microsoft Azure from the perspective of architecture (Compute, Storage Communication) services and cost models. Cloud application development using third party APIs, Working with EC2 API – Google App Engine API - Facebook API, Twitter API.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Rajkumar Buyya, James Broberg, Andrzej, M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 1st Edition, 2013.
2.	Sosinsk, Barrie, Cloud Computing Bible, John Wiley & Sons, 1st Edition, 2011.
Reference Books	
1.	Marinescu, Dan C. Cloud Computing: Theory and Practice. Morgan Kaufmann, 2017.
2.	Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Mc Graw Hill Education, 1st Edition, 2017.
3.	Buyya, Rajkumar, Christian Vecchiola, and S. Thamarai Selvi. Mastering Cloud Computing: Foundations and Applications Programming, Tata Mcgraw Hill, 1st Edition, 2017.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

List of Experiments		
1.	Configure a VM instance in your local machine and in cloud (by creating a cloud account). Allocate CPU, memory and storage space as per a specified requirement. Install Guest OS image in that instance, launch the same and confirm the successful installation of the OS by performing few OS commands.	3 hours
2.	Configure a Nested Virtual Machine (VM under another VM) in cloud and local machine. Install OS images and work with few OS commands.	2 hours
3	Create a ssh tunnel between your server in local machine and remote clients in EC2 instances and test the connections with programs using X11 traffic	3 hours
4.	Install the Hadoop framework and create an application using Map Reduce Programming Model	2 hours
5.	Perform live QEMU-KVM VM migrations using NFS	3 hours
6.	Experiment cloud scheduling algorithms using Cloud Sim/ OPNET / CloudAnalyst tool.	3 hours
7.	Experiment cloud load balancing algorithms using Cloud Sim/ OPNET/ CloudAnalyst tool.	2 hours
8.	Monitor, visualize and analyze performance of resource utilization in cloud platforms using Grafana tool.	2 hours

9.	Configure a VLAN using cisco packet tracer and analyze traffic issues	2 hours
10.	Build container images, launch the container instance in the cloud and run an application inside the container instance in cloud	2 hours
11.	EC2 AWS – Instance Creation, Migration	2 hours
12.	DaaS – Deployment of a basic web app and add additional Functionality (Javascripts based)	2 hours
13.	SaaS – Deployment of any SaaS application for a online Collaborative tool	2 hours
	Total Laboratory Hours	30 hours

Mode of Evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT).

Typical Projects:

1. Smart Traffic Management
2. Chatbots
3. Bug Tracker
4. Attendance Tracker
5. Android Offloading
6. Blood Banking Via Cloud Computing

Mode of evaluation: Review I, II and III.

Course code	EDGE COMPUTING	L	T	P	J	C
CSE3110		2	0	2	4	4
Pre-requisite	-	Syllabus version				
		v. 1.0				

Course Objectives

1. To learn and understand basic concepts in edge computing technology
2. To design and develop edge computing based applications
3. To learn and understand basic concepts of serverless computing and its relationship with edge computing

Course Outcome

1. To identify suitable edge computing architecture for an edge computing application.
2. To identify suitable networking models for edge computing
3. To identify suitable storage models for edge computing
4. To learn about resource allocation models in/for edge computing
5. To understand serverless computing and relate it to edge computing
6. To identify and mitigate security solutions for edge computing

Module:1	Introduction	3 hours

Evolution of Edge Computing – Edge Computing: Definition, Architecture and Characteristics – Edge Computing Applications – Open Challenges

Module:2	Edge Computing Architectures	5 hours

Intrinsic edge computing architecture - Standard reference architecture - Edge computing as a VNF - Edge computing in a standard mobile reference model – Open issues and challenges

Module:3	Networking models for edge computing	3 hours

Edge device peer-to-peer networking - Edge device to fog layer networking - Open issues and challenges

Module:4	Computing and storage models for edge computing	4 hours

Characteristics of the ecosystem - Computing models and platforms - Storage models and systems - Edge computing case study - Edge storage case study – Open issues and Challenges

Module:5	Resource allocation models in/for edge computing	5 hours

Definitions and concepts in resource allocation in/for edge computing - Task offloading and resource allocation - Server placement - Service caching - Service migration - Resilient and dynamic resource allocation - Edge federation framework

Module:6	Serverless architecture for edge computing	5 hours

Serverless computing - Combining serverless and edge computing – Resource model - Function orchestration - State storage - Communication model

Module:7	Data security and privacy models for/on edge computing	3 hours

Intrusion - Access control - Security and privacy solutions

Module:8	Contemporary Topics	2 hours
	Total Lecture hours	30 hours

Text Book(s)

1. Javid Taheri, and Shuiguang Deng, Edge Computing: Models, technologies and

	applications, 2020, First Edition, Institution of Engineering and Technology Publication, ISBN-13 : 978-1785619403
Reference Books	
1.	Rajkumar Buyya, Satish Narayana Srirama, Fog and Edge Computing: Principles and Paradigms, 2019, Wiley, USA, ISBN-13: 9781119525066.
2.	Cao, Jie., Zhang, Quan., Shi, Weisong. Edge Computing: A Primer, 2018, Springer International Publishing, Germany, ISBN-13: 9783030020835
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz, Final Assessment Test (FAT).	
Indicative Experiments	
1.	Working with IoT sensors: Build a basic IoT sensor application using Python, MQTT and AWS DynamoDB
2.	Embedded Linux Development Fundamentals: Learn to create a custom Linux image
3.	IoT Communications: Web application using WebAPI data, MQTT notifications and dashboard visualization
4.	Linux Device Drivers for Sensor Communication: Develop a low-level Linux kernel driver to interface with sensor hardware
5.	Edge Device User Interface Development: Explore UI/UX design by building an application for LCD panel
6.	Edge Computing Applications: Design and develop distributed computing applications using TensorFlow – Lite
7.	Edge Computing with Raspberry Pi
Total Laboratory Hours	30 hours
Mode of Evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT).	
Indicative Projects	
1. CCTV system enabled by edge computing 2. Smart home enabled by edge computing 3. Intelligent manufacturing enabled by edge computing 4. Specific applications of edge computing in urban traffic 5. Implementation for edge-based smart healthcare system 6. The Edge-based Health Information System 7. Edge computing-enabled solutions for smart grids 8. Edge-enabled solutions to the smart grid security problems	
Mode of evaluation: Review I, II and III.	

UNIVERSITY CORE

CHY1701	Engineering Chemistry (UC)	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**Chemistry of 12th standard or equivalent**	**Syllabus version**				
		1.1				

Course Objectives:

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

Expected Course Outcomes (CO): Students will be able to

1. **Recall** and **analyze** the issues related to impurities in water and their removal methods and **apply** recent methodologies in water treatment for domestic and industrial usage
2. **Evaluate** the causes of metallic corrosion and **apply** the methods for corrosion protection of metals
3. **Evaluate** the electrochemical energy storage systems such as lithium batteries, fuel cells and solar cells, and **design** for usage in electrical and electronic applications
4. **Assess** the quality of different fossil fuels and create an awareness to **develop** the alternative fuels
5. **Analyze** the properties of different polymers and distinguish the polymers which can be degraded and **demonstrate** their usefulness
6. **Apply** the theoretical aspects: (a) in **assessing** the water quality; (b) **understanding** the construction and working of electrochemical cells; (c) **analyzing** metals, alloys and soil using instrumental methods; (d) **evaluating** the viscosity and water absorbing properties of polymeric materials

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

Module:3	**Corrosion**	**6 hours**

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 NO_X; Knocking in IC engines-Octane and Cetane number - Antiknocking agents.

Module:7	**Polymers**	**6 hours**
Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - ABS, PVC, PTFE and Bakelite; Compounding of plastics: moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays, (Compression moulding), Fibre reinforced polymers, Composites (Transfer moulding), PET bottles (blow moulding); Conducting polymers- Polyacetylene- Mechanism of conduction – applications (polymers in sensors, self-cleaning windows)		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	1. Sashi Chawla, A Text book of Engineering Chemistry, Dhanpat Rai Publishing Co., Pvt. Ltd., Educational and Technical Publishers, New Delhi, 3rd Edition, 2015. 2. O.G. Palanna, McGraw Hill Education (India) Private Limited, 9th Reprint, 2015. 3. B. Sivasankar, Engineering Chemistry 1st Edition, Mc Graw Hill Education (India), 2008 4. Photovoltaic solar energy : From fundamentals to Applications , Ang le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Wiley publishers, 2017.
Reference Books	
2	1. O.V. Roussak and H.D. Gesser, ***Applied Chemistry-A Text Book for Engineers and Technologists***, Springer Science Business Media, New York, 2nd Edition, 2013. 2. S. S. Dara, ***A Text book of Engineering Chemistry,*** S. Chand & Co Ltd., New Delhi, 20th Edition, 2013.
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT	

List of Experiments

	Experiment title	Hours
1.	Water Purification: Estimation of water hardness by EDTA method and its removal by ion-exchange resin	1 h 30 min
2. 3.	Water Quality Monitoring: Assessment of total dissolved oxygen in different water samples by Winkler's method Estimation of sulphate/chloride in drinking water by conductivity method	3 h
4/5.	**Material Analysis: Quantitative colorimetric determination of divalent metal ions of Ni/Fe/Cu using conventional and smart phone digital-imaging methods**	**3h**
6.	Analysis of Iron in carbon steel by potentiometry	1 h 30 min
7.	Construction and working of an Zn-Cu electrochemical cell	1 h 30 min
8.	Determination of viscosity-average molecular weight of different natural/synthetic polymers	1 h 30 min
9.	**Arduino microcontroller based sensor for monitoring pH/temperature/conductivity in samples.**	**1 h 30 min**
	Total Laboratory Hours	17 hours

Mode of Evaluation: Viva-voce and Lab performance & FAT			
Recommended by Board of Studies	31-05-2019		
Approved by Academic Council	54th ACM	Date	13-06-2019

Course code	PROBLEM SOLVING AND PROGRAMMING	L	T	P	J	C
CSE1001		0	0	6	0	3
Pre-requisite	NIL	Syllabus version				
		v1.0				

Course Objectives:

1. To develop broad understanding of computers, programming languages and their generations
2. Introduce the essential skills for a logical thinking for problem solving
3. To gain expertise in essential skills in programming for problem solving using computer

Expected Course Outcome:

1. Understand the working principle of a computer and identify the purpose of a computer programming language.
2. Learn various problem solving approaches and ability to identify an appropriate approach to solve the problem
3. Differentiate the programming Language constructs appropriately to solve any problem
4. Solve various engineering problems using different data structures
5. Able to modulate the given problem using structural approach of programming
6. Efficiently handle data using flat files to process and store data for the given problem

List of Challenging Experiments (Indicative)

1	Steps in Problem Solving Drawing flowchart using yEd tool/Raptor Tool	4 Hours
2	Introduction to Python, Demo on IDE, Keywords, Identifiers, I/O Statements	4 Hours
3	Simple Program to display Hello world in Python	4 Hours
4	Operators and Expressions in Python	4 Hours
5	Algorithmic Approach 1: Sequential	4 Hours
6	Algorithmic Approach 2: Selection (if, elif, if.. else, nested if else)	4 Hours
7	Algorithmic Approach 3: Iteration (while and for)	6 Hours
8	Strings and its Operations	6 Hours
9	Regular Expressions	6 Hours
10	List and its operations	6 Hours
11	Dictionaries: operations	6 Hours
12	Tuples and its operations	6 Hours
13	Set and its operations	6 Hours
14	Functions, Recursions	6 Hours
15	Sorting Techniques (Bubble/Selection/Insertion)	6 Hours
16	Searching Techniques : Sequential Search and Binary Search	6 Hours
17	Files and its Operations	6 Hours
	Total hours:	**90 hours**

Text Book(s)

1. John V. Guttag., 2016. Introduction to computation and programming using python: with applications to understanding data. PHI Publisher.

Reference Books

1. Charles Severance.2016.Python for everybody: exploring data in Python 3, Charles Severance.
2. Charles Dierbach.2013.Introduction to computer science using python: a computational problem-solving focus. Wiley Publishers.

Mode of Evaluation: **PAT/ CAT / FAT**

Recommended by Board of Studies	04-04-2014		
Approved by Academic Council	No. 38	Date	23-10-2015

CSE1002	PROBLEM SOLVING AND OBJECT ORIENTED PROGRAMMING	L	T	P	J	C
		0	0	6	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		v. 1.0				

Course Objectives:

1. To emphasize the benefits of object oriented concepts.
2.To enable students to solve the real time applications using object oriented programmingfeatures
3.To improve the skills of a logical thinking and to solve the problems using any processing elements

Expected Course Outcome:

1. Demonstrate the basics of procedural programming and to represent the real world entitiesas programming constructs.
2.Enumerate object oriented concepts and translate real-world applications into graphical representations.
3.Demonstrate the usage of classes and objects of the real world entities in applications.
4.Discriminate the reusability and multiple interfaces with same functionality based featuresto solve complex computing problems.
5. Illustrate possible error-handling constructs for unanticipated states/inputs and to use generic programming constructs to accommodate different datatypes.
6. Validate the program against file inputs towards solving the problem..

List of Challenging Experiments (Indicative)

1.	**Postman Problem** A postman needs to walk down every street in his area in order to deliver the mail. Assume that the distances between the streets along the roads are given. The postman starts at the post office and returns back to the post office after delivering all the mails. Implement an algorithm to help the post man to walk minimum distance for the purpose.	10 hours
2.	**Budget Allocation for Marketing Campaign** A mobile manufacturing company has got several marketing options such as Radio advertisement campaign, TV non peak hours campaign, City top paper network, Viral marketing campaign, Web advertising. From their previous experience, they have got a statistics about paybacks for each marketing option. Given the marketing budget (rupees in crores) for the current year and details of paybacks for each option, implement an algorithm to determine the amount that shall spent on each marketing option so that the company attains the maximum profit.	15 hours
3.	**Missionaries and Cannibals** Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Implement an algorithm to find a way to get everyone to the other side of the river, without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place.	10 hours
4.	**Register Allocation Problem** A register is a component of a computer processor that can hold any type of	15 hours

	data and can be accessed faster. As registers are faster to access, it is desirable to use them to the maximum so that the code execution is faster. For each code submitted to the processor, a register interference graph (RIG) is constructed. In a RIG, a node represents a temporary variable and an edge is added between two nodes (variables) t1 and t2 if they are live simultaneously at some point in the program. During register allocation, two temporaries can be allocated to the same register if there is no edge connecting them. Given a RIG representing the dependencies between variables in a code, implement an algorithm to determine the number of registers required to store the variables and speed up the code execution	
5.	**Selective Job Scheduling Problem** A server is a machine that waits for requests from other machines and responds to them. The purpose of a server is to share hardware and software resources among clients. All the clients submit the jobs to the server for execution and the server may get multiple requests at a time. In such a situation, the server schedule the jobs submitted to it based on some criteria and logic. Each job contains two values namely time and memory required for execution. Assume that there are two servers that schedules jobs based on time and memory. The servers are named as Time Schedule Server and memory Schedule Server respectively. Design a OOP model and implement the time Schedule Server and memory Schedule Server. The Time Schedule Server arranges jobs based on time required for execution in ascending order whereas memory Schedule Server arranges jobs based on memory required for execution in ascending order	15 hours
6.	**Fragment Assembly in DNA Sequencing** DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other organisms. The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). In DNA sequencing, each DNA is sheared into millions of small fragments (reads) which assemble to form a single genomic sequence (superstring). Each read is a small string. In such a fragment assembly, given a set of reads, the objective is to determine the shortest superstring that contains all the reads. For example, given a set of strings, 000, 001, 010, 011, 100, 101, 110, 111 the shortest superstring is 0001110100. Given a set of reads, implement an algorithm to find the shortest superstring that contains all the given reads.	15 hours
7.	**House Wiring** An electrician is wiring a house which has many rooms. Each room has many power points in different locations. Given a set of power points and the distances between them, implement an algorithm to find the minimum cable required.	10 hours
	Total Laboratory Hours	**90 hours**

Text Book(s)	
1.	Stanley B Lippman, Josee Lajoie, Barbara E, Moo, C++ primer, Fifth edition, Addison-Wesley, 2012.
2	Ali Bahrami, Object oriented Systems development, Tata McGraw - Hill Education, 1999.
3	Brian W. Kernighan, Dennis M. Ritchie , The C programming Language, 2nd edition, Prentice Hall Inc., 1988.
Reference Books	
1.	Bjarne stroustrup, The C++ programming Language, Addison Wesley, 4th edition, 2013
2.	Harvey M. Deitel and Paul J. Deitel, C++ How to Program, 7th edition, Prentice Hall, 2010
3.	Maureen Sprankle and Jim Hubbard, Problem solving and Programming concepts, 9th edition, Pearson Eduction, 2014.

Mode of assessment: **PAT / CAT / FAT**			
Recommended by Board of Studies	29-10-2015		
Approved by Academic Council	No. 39	Date	17-12-2015

CSE1902	Industrial Internship	L	T	P	J	C
		0	0	0	0	1
Pre-requisite	Completion of minimum of Two semesters					

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	28-02-2016		
Approved by Academic Council	No. 37	Date	16-06-2015

CSE1901	Technical Answers for Real World Problems (TARP)	L	T	P	J	C
		1	0	0	4	2

Pre-requisite	Nil	Syllabus version
		1.0

Course Objectives:

- To help students to identify the need for developing newer technologies for industrial / societal needs
- To train students to propose and implement relevant technology for the development ofthe prototypes / products
- To make the students learn to the use the methodologies available for analysing 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 usingengineering principles and arrive at innovative solutions

Module:1 **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, economical, 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	28-02-2016		
Approved by Academic Council	No.37	Date	16-06-2015

CSE1903	Comprehensive Examination	L	T	P	J	C
		0	0	0	0	1
Pre-requisite		**Syllabus version**				
		1.00				

Digital Logic and Microprocessor

Simplification of Boolean functions using K-Map – Combinational logic: Adder, subtractor, encoder, decoder, multiplexer, de-multiplexer – Sequential Logic: Flip flops- 8086 Microprocessor: instructions – peripherals: 8255, 8254, 8257.

Computer Architecture and Organization

Instructions - Instruction types- Instruction Formats - Addressing Modes- Pipelining- Data Representation - Memory Hierarchy- Cache memory-Virtual Memory- I/O Fundamentals- I/O Techniques - Direct Memory Access - Interrupts-RAID architecture

Programming, Data Structures and Algorithms

Programming in C; Algorithm Analysis – Iterative and Recursive Algorithms; ADT - Stack and its Applications - Queue and its Applications; Data Structures – Arrays and Linked Lists; Algorithms - Sorting – Searching; Trees – BST, AVL; Graphs – BFS , DFS , Dijkstra's Shortest Path Algorithm.

Theory of Computation

Deterministic Finite Automata, Non deterministic Finite Automata, Regular Expressions, Context Free Grammar, Push down Automata and Context Free Languages, Turing Machines.

Web Technologies

Web Architecture- JavaScript – objects String, date, Array, Regular Expressions, DHTML- HTML DOM Events; Web Server – HTTP- Request/Response model-RESTful methods- State Management – Cookies , Sessions – AJAX.

Operating Systems

Processes, Threads, Inter-process communication, CPU scheduling, Concurrency and synchronization, Deadlocks, Memory management and Virtual memory & File systems.

Database Management System

DBMS, Schema, catalog, metadata, data independence, pre-compiler; Users-naïve, sophisticated, casual ;ER Model- Entity, attributes, structural constraints; Relational Model-Constraints, Relational Algebra operations; SQL- DDL, DML, TCL, DCL commands, basic queries and Top N queries; Normalization-properties, 1NF, 2NF, 3NF, BCNF; Indexing-different types, Hash Vs B-tree Index; Transaction-problems, Concurrency Control-techniques, Recovery-methods.

Data Communication and Computer Networks

Circuit Switching, Packet Switching, Frame Relay, Cell Switching, ATM , OSI Reference model, TCP\IP, Network topologies, LAN Technologies, Error detection and correction techniques, Internet protocols , IPv4/IPv6, Routing algorithms, TCP and UDP, Sockets, Congestion control, Application Layer Protocols, Network Security: Basics of public and private key cryptosystems- Digital Signatures and Hash codes, Transport layer security, VPN, Firewalls.

Recommended by Board of Studies	05-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

CSE1904	Capstone Project	L	T	P	J	C
		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 product / 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. Synthesise 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, fabrication of new equipment, 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	10.06.2015		
Approved by Academic Council	37th AC	Date	16.06.2015

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**				
		1				

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 Pres.
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	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
		1

Course Objectives:

1. To acquire proficiency levels in LSRW skills on par with the requirements for placement interviews of high-end companies / competitive exams.
2. To evaluate complex arguments and to articulate their own positions on a range of technical and general topics.
3. To speak in grammatical and acceptable English with minimal MTI, as well as develop a vast and active vocabulary.

Expected Course Outcome:

1. Communicate proficiently in high-end interviews and exam situations and all social situations
2. Comprehend academic articles and draw inferences
3. Evaluate different perspectives on a topic
4. Write clearly and convincingly in academic as well as general contexts
5. Synthesize complex concepts and present them in speech and writing

Module:1	Listening for Clear Pronunciation	4 hours

Ice-breaking, Introduction to vowels, consonants, diphthongs.

Listening to formal conversations in British and American accents (BBC and CNN) as well as other 'native' accents

Activity: Factual and interpretive exercises; note-making in a variety of global English accents

Module:2	Introducing Oneself	4 hours

Speaking: Individual Presentations

Activity: Self-Introductions, Extempore speech

Module:3	Effective Writing	6 hours

Writing: Business letters and Emails, Minutes and Memos

Structure/ template of common business letters and emails: inquiry/ complaint/ placing an order; Formats of Minutes and Memos

Activity: Students write a business letter and Minutes/ Memo

Module:4	Comprehensive Reading	4 hours

Reading: Reading Comprehension Passages, Sentence Completion (Technical and General Interest), Vocabulary and Word Analogy

Activities: Cloze tests, Logical reasoning, Advanced grammar exercises

Module:5	Listening to Narratives	4 hours

Listening: Listening to audio files of short stories, News, TV Clips/ Documentaries, Motivational Speeches in UK/ US/ global English accents.

Activity: Note-making and Interpretive exercises

Module:6	**Academic Writing and Editing**	**6 hours**
Writing: Editing/ Proofreading symbols Citation Formats Structure of an Abstract and Research Paper Activity: Writing Abstracts and research paper; Work with Editing/ Proofreading exercise		
Module:7	**Team Communication**	**4 hours**
Speaking: Group Discussions and Debates on complex/ contemporary topics Discussion evaluation parameters, using logic in debates Activity: Group Discussions on general topics		
Module:8	**Career-oriented Writing**	**4 hours**
Writing: Resumes and Job Application Letters, SOP Activity: Writing resumes and SOPs		
Module:9	**Reading for Pleasure**	**4 hours**
Reading: Reading short stories Activity: Classroom discussion and note-making, critical appreciation of the short story		
Module: 10	**Creative Writing**	**4 hours**
Writing: Imaginative, narrative and descriptive prose Activity: Writing about personal experiences, unforgettable incidents, travelogues		
Module: 11	**Academic Listening**	**4 hours**
Listening: Listening in academic contexts Activity: Listening to lectures, Academic Discussions, Debates, Review Presentations, 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 ed. 2016.
	Online Sources: https://americanliterature.com/short-short-stories. (75 *short* short stories) http://www.eco-ction.org/dt/thinking.html (Leopold, Aldo."Thinking like a Mountain") /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	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				
		1				

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 discussion on decision making skills

Module:2	Writing reviews and abstracts through movie interpretations	5 hours

Review writing and abstract writing with competency

Activity: Watching Charles Dickens "Great Expectations" and writing a movie review

Watching William F. Nolan's "Logan's Run" and analyzing it in tune with the present scenario of depletion of resources and writing an abstract

Module:3	Technical Writing	4 hours

Stimulate effective linguistics for writing: content and style

Activity: Proofreading

Statement of Purpose

Module:4	Trans-Cultural Communication	4 hours

Nuances of Trans-cultural communication

Activity:

Group discussion and case studies on trans-cultural communication.

Debate on trans-cultural communication.

Module:5	**Report Writing and Content Writing**	**4 hours**
Enhancing reportage on relevant audio-visuals Activity: Watch a documentary on social issues and draft a report Identify a video on any social issue and interpret		
Module:6	**Drafting project proposals and article writing**	**4 hours**
Dynamics of drafting project proposals and research articles Activity: Writing a project proposal. Writing a research article.		
Module:7	**Technical Presentations**	**4 hours**
Build smart presentation skills and strategies Activity: Technical presentations using PPT and Web tools		
	Total Lecture hours	**30 hours**

Text Book / Workbook	
1.	Raman, Meenakshi & Sangeeta Sharma. *Technical Communication: Principles and Practice*, 3rd edition, Oxford University Press, 2015.
Reference Books	
1	Basu B.N. *Technical Writing*, 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 Academic Publishing, 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	55	Date: 13-06-2019

Course code	Course title	L	T	P	J	C
PHY1901	Introduction to Innovative Projects	1	0	0	0	1
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

This course is offered to the students in the 1 Year of B.Tech. in order to orient them towards independent, systemic thinking and be innovative.

1. To make students confident enough to handle the day to day issues.
2. To develop the "Thinking Skill" of the students, especially Creative Thinking Skills
3. To train the students to be innovative in all their activities
4. To prepare a project report on a socially relevant theme as a solution to the existing issues

Expected Course Outcome: Students will be able to

1. Understand the various types of thinking skills.
2. Enhance the innovative and creative ideas.
3. Find out a suitable solution for socially relevant issues- J component

Module:1 A	Self Confidence	1 hour

Understanding self – Johari Window –SWOT Analysis – Self Esteem – Being a contributor – Case Study

Project : Exploring self, understanding surrounding, thinking about how s(he) can be a contributor for the society, Creating a big picture of being an innovator – writing a 1000 words imaginary autobiography of self – Topic "Mr X – the great innovator of 2015" and upload. **(4 non- contact hours)**

Module:1 B	Thinking Skill	1 hour

Thinking and Behaviour – Types of thinking– Concrete – Abstract, Convergent, Divergent, Creative, Analytical, Sequential and Holistic thinking – Chunking Triangle – Context Grid – Examples – Case Study.

Project : Meeting at least 50 people belonging to various strata of life and talk to them / make field visits to identify a min of100 society related issues, problems for which they need solutions and categories them and upload along with details of people met and lessons learnt. **(4 non-contact hours)**

Module:1 C	Lateral Thinking Skill	1 hour

Blooms Taxonomy – HOTS – Outof the box thinking – deBono lateral thinking model – Examples **Project :** Last weeks - incomplete portion to be done and uploaded		
Module:2 A	**Creativity**	**1 hour**
Creativity Models – Walla – Barrons – Koberg & Begnall – Examples **Project :** Selecting 5 out of 100 issues identified for future work. Criteria based approach for prioritisation, use of statistical tools & upload . **(4 non- contact hours)**		
Module:2 B	**Brainstorming**	**1 hour**
25 brainstorming techniques and examples **Project :** Brainstorm and come out with as many solutions as possible for the top 5 issues identified & upload . **(4 non- contact hours)**		
Module:3	**Mind Mapping**	**1 hour**
Mind Mapping techniques and guidelines. Drawing a mind map **Project :** Using Mind Maps get another set of solutions forthe next 5 issues (issue 6 – 10) . **(4 non- contact hours)**		
Module:4 A	**Systems thinking**	**1 hour**
Systems Thinking essentials – examples – Counter Intuitive condemns **Project :** Select 1 issue / problem for which the possible solutions are available with you. Apply Systems Thinking process and pick up one solution [explanation should be given why the other possible solutions have been left out]. Go back to the customer and assess the acceptability and upload. . **(4 non- contact hours)**		
Module:4 B	**Design Thinking**	**1 hour**
Design thinking process – Human element of design thinking – case study **Project :** Apply design thinking to the selected solution, apply the engineering & scientific tinge to it. Participate in "design week" celebrations upload the weeks learning out come.		
Module:5 A	**Innovation**	**1 hour**
Difference between Creativity and Innovation – Examples of innovation –Being innovative. **Project:** A literature searches on prototyping of your solution finalized. Prepare a prototype model or process and upload. . **(4 non- contact hours)**		
Module:5 B	**Blocks for Innovation**	**1 hour**
Identify Blocks for creativity and innovation – overcoming obstacles – Case Study **Project :** Project presentation on problem identification, solution, innovations-expected results – Interim review with PPT presentation. . **(4 non- contact hours)**		
Module:5 C	**Innovation Process**	**1 hour**
Steps for Innovation – right climate for innovation **Project:** Refining the project, based on the review report and uploading the text. . **(4 non-contact hours)**		
Module:6 A	**Innovation in India**	**1 hour**
Stories of 10 Indian innovations **Project:** Making the project better with add ons. . **(4 non- contact hours)**		
Module:6 B	**JUGAAD Innovation**	**1 hour**
Frugal and flexible approach to innovation - doing more with less Indian Examples **Project:** Fine tuning the innovation project with JUGAAD principles and uploading (Credit for JUGAAD implementation) . **(4 non- contact hours)**		
Module:7 A	**Innovation Project Proposal Presentation**	**1 hour**
Project proposal contents, economic input, ROI – Template **Project:** Presentation of the innovative project proposal and upload . **(4 non- contact hours)**		
Module:8 A	Contemporary issue in Innovation	**1 hour**

Contemporary issue in Innovation **Project:** Final project Presentation , Viva voce Exam (**4 non- contact hours)**			
	Total Lecture hours:	**15 hours**	
Text Book(s)			
1.	How to have Creative Ideas, Edward debone, Vermilon publication, UK, 2007		
2.	The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008		
Reference Books			
1.	Creating Confidence, Meribeth Bonct, Kogan Page India Ltd, New Delhi, 2000		
2.	Lateral Thinking Skills, Paul Sloane, Keogan Page India Ltd, New Delhi, 2008		
3.	Indian Innovators, Akhat Agrawal, Jaico Books, Mumbai, 2015		
4.	JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar Three reviews with weightage of 25 : 25 : 50 along with reports			
Recommended by Board of Studies	15-12-2015		
Approved by Academic Council	No. 39	Date	17-12-2015

HUM1021	ETHICS AND VALUES	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	Nil	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society andpolity
2. To understand the negative health impacts of certain unhealthy behaviors
3. To appreciate the need and importance of physical, emotional health and social health

Expected Course Outcome:

Students will be able to:

1. Follow sound morals and ethical values scrupulously to prove as good citizens
2. Understand various social problems and learn to act ethically
3. Understand the concept of addiction and how it will affect the physical and mental health
4. EX
5. 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:**	**2 hours**

Guest lectures by Experts

	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.
3.	Pagliaro, L.A. and Pagliaro, A.M, "Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological , Developmental and Clinical Considerations", 2012Wiley Publishers, U.S.A.
4.	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

MAT1011	Calculus for Engineers	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	10+2 Mathematics	Syllabus Version				
		1.0				

Course Objectives :

1. To provide the requisite and relevant background necessary to understand theother important engineering mathematics courses offered for Engineers and Scientists.
2. To introduce important topics of applied mathematics, namely Singleand Multivariable Calculus and Vector Calculus etc.
3. To impart the knowledge of Laplace transform, an important transform technique for Engineers which requires knowledge of integration

Expected Course Outcomes:

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

1. apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions
2. understand basic concepts of Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution
3. evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints
4. evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.
5. understand gradient, directional derivatives, divergence, curl and Greens", Stokes, Gauss theorems
6. demonstrate MATLAB code for challenging problems in engineering

Module:1	Application of Single Variable Calculus	9 hours

Differentiation- Extrema on an Interval-Rolle"s Theorem and the Mean Value Theorem-Increasing and Decreasing functions and First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution - Beta and Gamma functions–interrelation

Module:2	Laplace transforms	7 hours

Definition of Laplace transform-Properties-Laplace transform of periodic functions-Laplace transform of unit step function, Impulse function-Inverse Laplace transform-Convolution.

Module:3	Multivariable Calculus	4 hours

Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.

Module:4	Application of Multivariable Calculus	5 hours

Taylor"s expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange"s multiplier method.

Module:5	Multiple integrals	8 hours

Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - Evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates- evaluation of multiple integrals using gamma and beta functions.

Module:6	**Vector Differentiation**	**5 hours**
Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials–Statement of vector identities-Simple problems		
Module:7	**Vector Integration**	**5 hours**
line, surface and volume integrals - Statement of Green‟s, Stoke‟s and Gauss divergence theorems -verification and evaluation of vector integrals using them.		
Module:8	**Contemporary Issues:**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**

Text Book(s)

[1] Thomas‟ Calculus, George B.Thomas, D.Weir and J. Hass, 13th edition, Pearson, 2014.
[2] Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India, 2015.

Reference Books

1. Higher Engineering Mathematics, B.S. Grewal, 43rd Edition ,Khanna Publishers, 2015
2. Higher Engineering Mathematics, John Bird, 6th Edition, Elsevier Limited, 2017.
3. Calculus: Early Transcendentals, James Stewart, 8th edition, Cengage Learning, 2017.
4. Engineering Mathematics, K.A.Stroud and Dexter J. Booth, 7th Edition, Palgrave Macmillan (2013)

Mode of Evaluation

Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test

List of Challenging Experiments (Indicative)		
1.	Introduction to MATLAB through matrices, and general Syntax	2 hours
2	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB	2 hours
3.	Evaluating Extremum of a single variable function	2 hours
4.	Understanding integration as Area under the curve	2 hours
5.	Evaluation of Volume by Integrals (Solids of Revolution)	2 hours
6.	Evaluating maxima and minima of functions of several variables	2 hours
7.	Applying Lagrange multiplier optimization method	2 hours
8.	Evaluating Volume under surfaces	2 hours
9.	Evaluating triple integrals	2 hours
10.	Evaluating gradient, curl and divergence	2 hours
11.	Evaluating line integrals in vectors	2 hours
12.	Applying Green's theorem to real world problems	2 hours
	Total Laboratory Hours	**24 hours**

Mode of Assessment:

Weekly assessment, Final Assessment Test

Recommended by Board of Studies	12-06-2015		
Approved by Academic Council	No. 37	Date	16-06-2015

MAT2001	Statistics for Engineers	L	T	P	J	C
		3	0	2	0	4
Prerequisites	**MAT1011 – Calculus for Engineers**	**Syllabus Version**:				1.0

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

Expected Course Outcome:

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

1. Compute and interpret descriptive statistics using numerical and graphical techniques.
2. Understand the basic concepts of random variables and find an appropriate distribution for analysing data specific to an experiment.
3. Apply statistical methods like correlation, regression analysis in analysing, interpreting experimental data.
4. Make appropriate decisions using statistical inference that is the central to experimental research.
5. Use statistical methodology and tools in reliability engineering problems.
6. demonstrate R programming for statistical data

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

Introduction to statistics and data analysis-Measures of central tendency –Measures of variability-[Moments-Skewness-Kurtosis (Concepts only)].

Module: 2	**Random variables**	**8 hours**

Introduction -random variables-Probability mass Function, distribution and density functions - joint Probability distribution and joint density functions- Marginal, conditional distribution and density functions- Mathematical expectation, and its properties Covariance , moment generating function – characteristic function.

Module: 3	**Correlation and regression**	**4 hours**

Correlation and Regression – Rank Correlation- Partial and Multiple correlation- Multiple regression.

Module: 4	**Probability Distributions**	**7 hours**

Binomial and Poisson distributions – Normal distribution – Gamma distribution – Exponential distribution – Weibull distribution.

Module: 5	**Hypothesis Testing I**	**4 hours**

Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis-Large sample tests- Z test for Single Proportion, Difference of Proportion, mean and difference of means.

Module: 6	**Hypothesis Testing II**	**9 hours**

Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – one and two way classifications - CRD-RBD- LSD.

Module: 7	**Reliability**	**5 hours**

Basic concepts- Hazard function-Reliabilities of series and parallel systems- System Reliability - Maintainability-Preventive and repair maintenance- Availability.

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

Text book(s)

- Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
- Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons (2016).

Reference books

- Reliability Engineering, E.Balagurusamy, Tata McGraw Hill, Tenth reprint 2017.
- Probability and Statistics, J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012).
- Probability and Statistics for Engineers, R.A.Johnson, Miller Freund's, 8th edition, Prentice Hall India (2011).
- Probability, Statistics and Reliability for Engineers and Scientists, Bilal M. Ayyub and Richard H. McCuen, 3rd edition, CRC press (2011).

Mode of Evaluation

Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test.

List of Experiments (Indicative)		
•	Introduction: Understanding Data types; importing/exporting data.	2 hours
•	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations.	2 hours
•	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination.	2 hours
•	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficient of determination.	2 hours
•	Fitting the following probability distributions: Binomial distribution	2 hours
•	Normal distribution, Poisson distribution	2 hours
•	Testing of hypothesis for One sample mean and proportion from real-time problems.	2 hours
•	Testing of hypothesis for Two sample means and proportion from real-time problems	2 hours
•	Applying the t test for independent and dependent samples	2 hours
•	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	2 hours
•	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design ,Latin square Design	2 hours
	Total laboratory hours	**22 hours**

Mode of Evaluation

Weekly Assessment, Final Assessment Test

Recommended by Board of Studies	25-02-2017		
Approved by Academic Council	47	Date:	05-10-2017

MGT1022	Lean Start up Management	L	T	P	J	C
		1	0	0	4	2
Pre-requisite	Nil	**Syllabus version**				
		v.1.0				

Course Objectives: To develop the ability to

1. Learn methods of company formation and management.
2. Gain practical skills in and experience of stating of business using pre-set collection of business ideas.
3. Learn basics of entrepreneurial skills.

Expected Course Outcome: On the completion of this course the student will be able to:

1. Understand developing business models and growth drivers
2. Use the business model canvas to map out key components of enterprise
3. Analyze market size, cost structure, revenue streams, and value chain
4. Understand build-measure-learn principles
5. Foreseeing and quantifying business and financial risks

Module:1	**2 Hours**
Creativity and Design Thinking (identify the vertical for business opportunity, understand your customers, accurately assess market opportunity)	

Module:2	**3 Hours**
Minimum Viable Product (Value Proposition, Customer Segments, Build- measure-learn process)	

Module:3	**3 Hours**
Business Model Development(Channels and Partners, Revenue Model and streams, Key Resources, Activities and Costs, Customer Relationships and Customer Development Processes, Business model canvas –the lean model- templates)	

Module:4	**3 Hours**
Business Plan and Access to Funding(visioning your venture, taking the product/ service to market, Market plan including Digital & Viral Marketing, start-up finance - Costs/Profits & Losses/cash flow, Angel/VC,/Bank Loans and Key elements of raising money)	

Module:5	**3 Hours**
Legal, Regulatory, CSR, Standards, Taxes	

Module:6	**2 Hours**
Lectures by Entrepreneurs	

	Total Lecture	**15 hours**

Text Book(s)

1. The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, Steve Blank, K & S Ranch; 1st edition (March 1, 2012)
2. The Four Steps to the Epiphany, Steve Blank, K&S Ranch; 2nd edition (July 17, 2013)
3. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Crown Business; (13 September 2011)

Reference Books	
1.	Holding a Cat by the Tail, Steve Blank, K&S Ranch Publishing LLC (August 14, 2014)
2	Product Design and Development, Karal T Ulrich, SD Eppinger, McGraw Hill
3	Zero to One: Notes on Startups, or How to Build the Future, Peter Thiel, Crown Business(2014)
4	Lean Analytics: Use Datato Build a Better Startup Faster (Lean Series), Alistair Croll& Benjamin Yoskovitz, O'Reilly Media; 1st Edition (March 21, 2013)
5	Inspired: How To Create Products Customers Love, Marty Cagan, SVPG Press; 1st edition (June 18, 2008)
6	**Website References:** 1. http://theleanstartup.com/ 2. https://www.kickstarter.com/projects/881308232/only-on-kickstarter-the-leaders-guide-by-eric-ries 3. http://businessmodelgeneration.com/ 4. https://www.leanstartupmachine.com/ 5. https://www.youtube.com/watch?v=fEvKo90qBns 6. http://thenextweb.com/entrepreneur/2015/07/05/whats-wrong-with-the-lean-startup-methodology/#gref 7. http://www.businessinsider.in/Whats-Lean-about-Lean-Startup/articleshow/53615661.cms 8. https://steveblank.com/tools-and-blogs-for-entrepreneurs/ 9. https://hbr.org/2013/05/why-the-lean-start-up-changes-everything 10. chventures.blogspot.in/ platformsandnetworks.blogspot.in/p/saas-model.html

Mode of Evaluation: Assignments; Field Trips, Case Studies; e-learning; Learning through research, TED Talks

Project		
1.	Project	60 hours
	Total Project	**60 hours**

Recommended by Board of Studies	08-06-2015		
Approved by Academic Council	37	Date	16-06-2015

Total Practical Hours	**60 hours**

Mode of evaluation: Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities

Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 47	Date	24.08.2017

PHY1701	Engineering Physics	L	T	P	J	C
		3	0	2	0	4

Pre-requisite	None	Syllabus version
		V.2.1

Course Objectives:

To enable the students to understand the basics of the latest advancements in Physics viz., Quantum Mechanics, Nanotechnology, Lasers, Electro Magnetic Theory and Fiber Optics.

Expected Course Outcome: Students will be able to

1. Comprehend the dual nature of radiation and matter.
2. Compute Schrodinger"s equations to solve finite and infinite potential problems.
3. Analyze quantum ideas at the nanoscale.
4. Apply quantum ideas for understanding the operation and working principle ofoptoelectronic devices.
5. Recall the Maxwell"s equations in differential and integral form.
6. Design the various types of optical fibers for different Engineering applications.
7. Explain concept of Lorentz Transformation for Engineering applications.
8. Demonstrate the quantum mechanical ideas

Module:1	Introduction to Modern Physics	6 hours

Planck"s concept (hypothesis), Compton Effect, Particle properties of wave: Matter Waves, Davisson Germer Experiment, Heisenberg Uncertainty Principle, Wave function, and Schrodinger equation (time dependent & independent).

Module:2	Applications of Quantum Physics	5 hours

Particle in a 1-D box (Eigen Value and Eigen Function), 3-D Analysis (Qualitative), Tunneling Effect (Qualitative) (AB 205), Scanning Tunneling Microscope (STM).

Module:3	Nanophysics	5 hours

Introduction to Nano-materials, Moore"s law, Properties of Nano-materials, Quantum confinement, Quantum well, wire & dot, Carbon Nano-tubes (CNT), Applications of nanotechnology in industry.

Module:4	Laser Principles and Engineering Application	6 hours

Laser Characteristics, Spatial and Temporal Coherence, Einstein Coefficient & its significance, Population inversion, Two, three & four level systems, Pumping schemes, Threshold gain coefficient, Components of laser, Nd-YAG, He-Ne, CO2 and Dye laser and their engineering applications.

Module:5	Electromagnetic Theory and its application	6 hours

Physics of Divergence, Gradient and Curl, Qualitative understanding of surface and volume integral, Maxwell Equations (Qualitative), Wave Equation (Derivation), EM Waves, Phase velocity, Group velocity, Group index , Wave guide (Qualitative)

Module:6	Propagation of EM waves in Optical fibers and Optoelectronic Devices	10 hours

Light propagation through fibers, Acceptance angle, Numerical Aperture, Types of fibers - step index, graded index, single mode & multimode, Attenuation, Dispersion-intermodal and intramodal. Sources-LED & Laser Diode, Detectors-Photodetectors- PN & PIN - Applications of fiber optics in communication- Endoscopy.

Module:7	Special Theory of Relativity	5 hours

Frame of reference, Galilean relativity, Postulate of special theory of relativity, Simultaneity, length contraction and time dilation.

Module:8	Contemporary issues:	2 hours

Lecture by Industry Experts

	Total Lecture hours:	**45 hours**

Text Book(s)

1. Arthur Beiser et al., Concepts of Modern Physics, 2013, Sixth Edition, Tata McGraw Hill.
2. William Silfvast, Laser Fundamentals, 2008, Cambridge University Press.
3. D. J. Griffith, Introduction to Electrodynamics, 2014, 4th Edition, Pearson.
4. Djafar K. Mynbaev and Lowell L.Scheiner, Fiber Optic Communication Technology, 2011, Pearson

Reference Books

1. Raymond A. Serway, Clement J. Mosses, Curt A. Moyer Modern Physics, 2010, 3rd Indian Edition Cengage learning.
2. John R. Taylor, Chris D. Zafiratos and Michael A. Dubson, Modern Physics for Scientists and Engineers, 2011, PHI Learning Private Ltd.
3. Kenneth Krane Modern Physics, 2010, Wiley Indian Edition.
4. Nityanand Choudhary and Richa Verma, Laser Systems and Applications, 2011, PHI Learning Private Ltd.
5. S. Nagabhushana and B. Sathyanarayana, Lasers and Optical Instrumentation, 2010, I.K. International Publishing House Pvt. Ltd.,
6. R. Shevgaonkar, Electromagnetic Waves, 2005, 1st Edition, Tata McGraw Hill
7. Principles of Electromagnetics, Matthew N.O. Sadiku, 2010, Fourth Edition, Oxford.
8. Ajoy Ghatak and K. Thyagarajan, Introduction to Fiber Optics, 2010, Cambridge University Press.

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

List of Experiments

1.	Determination of Planck"s constant using electroluminescence process	2 hrs
2.	Electron diffraction	2 hrs
3.	Determination of wavelength of laser source (He -Ne laser and diode lasers of different wavelengths) using diffraction technique	2 hrs
4.	Determination of size of fine particle using laser diffraction	2 hrs
5.	Determination of the track width (periodicity) in a written CD	2 hrs
6.	Optical Fiber communication (source + optical fiber + detector)	2 hrs
7.	Analysis of crystallite size and strain in a nano -crystalline film using X-ray diffraction	2 hrs
8.	Numerical solutions of Schrödinger equation (e.g. particle in a box problem) (can be given as an assignment)	2 hrs
9.	Laser coherence length measurement	2 hrs
10.	Proof for transverse nature of E.M. waves	2 hrs
11.	Quantum confinement and Heisenberg's uncertainty principle	2 hrs
12.	Determination of angle of prism and refractive index for various colour – Spectrometer	2 hrs
13.	Determination of divergence of a laser beam	2 hrs
14.	Determination of crystalline size for nanomaterial (Computer simulation)	2 hrs
15.	Demonstration of phase velocity and group velocity (Computer simulation)	2 hrs
	Total Laboratory Hours	30 hrs

Mode of evaluation: CAT / FAT

Recommended by Board of Studies	04-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

<table>
<tr><td colspan="2">ESP1001</td><td colspan="2">ESPAÑOL FUNDAMENTAL</td><td>L
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0</td><td>P
0</td><td>J
0</td><td>C
2</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="2">Nil</td><td colspan="5">Syllabus version
1.0</td></tr>
<tr><td colspan="9">Course Objectives:</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td colspan="9">Expected Course Outcome:</td></tr>
<tr><td colspan="9">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</td></tr>
<tr><td>Module: 1</td><td colspan="6">Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Profesión</td><td>3 hours</td></tr>
<tr><td colspan="9">Competencia Gramática: Vocales y Consonantes. Artículos definidos e indefinidos (Numero y Genero).
Competencia Escrita: Saludos y Datos personales</td></tr>
<tr><td>Module: 2</td><td colspan="6">Edad y posesión. Números (1-20)</td><td>3 hours</td></tr>
<tr><td colspan="9">Competencia Gramática: Pronombres personales. Adjetivos. Los verbos SER y TENER.
Competencia Escrita: Escribe sobre mismo/a y los compañeros de la clase</td></tr>
<tr><td>Module: 3</td><td colspan="6">Vocabulario de Mi habitación. Colores. Descripción de lugares y cosas</td><td>5 hours</td></tr>
<tr><td colspan="9">Competencia Gramática: Adjetivos posesivos. El uso del verbo ESTAR. Diferencia entre SER y ESTAR.
Competencia Escrita: Mi habitación</td></tr>
<tr><td>Module: 4</td><td colspan="6">Mi familia. Números (21-100). Direcciones.Expresar la hora. Los meses del año.</td><td>5hours</td></tr>
<tr><td colspan="9">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</td></tr>
<tr><td>Module: 5</td><td colspan="6">Expresar fechas y el tiempo. Dar opiniones sobre personas y lugares.</td><td>5 hours</td></tr>
<tr><td colspan="9">Competencia Gramática: Los verbos regulares (-AR, -ER, -IR) en el presente. Adjetivos demostrativos.
Competencia Escrita: Mi mejor amigo/a. Expresar fechas. Traducción ingles a español y Español a</td></tr>
</table>

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	22.02.2016		
Approved by Academic Council	41st ACM	**Date**	17.06.2016

ESP2001	ESPAÑOL INTERMEDIO	L	T	P	J	C
		2	0	2	0	3
Pre-requisite		**Syllabus version**				
		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 planes futuros. 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 e informal.**	**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 una entrevista 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 los planes futuros.**	**5 hours**
Comprensión oral: Introducción personal, Expresar los planes futuros. ¿Qué vas a hacer en las próximas vacaciones? Comprensión auditiva: Las preguntas sobre un cuento auditivo. Relacionar el audio con las imágenes. 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 un restaurante, 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 el cuento. 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.	"Practice makes perfect: Basic Spanish", Dorothy Richmond, McGraw Hill Contemporary, USA 2009.
4.	"Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España, 2010.
	Authors, book title, year of publication, edition number, press, place

Recommended by Board of Studies	DD-MM-YYYY		
Approved by Academic Council	No.41	Date	17.06.2016

FRE1001	FRANÇAIS QUOTIDIEN	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		1.0				

Course Objectives:

The course gives students the necessary background to:

1. Learn the basics of French language and to communicate effectively in French in their day to day life.
2. Achieve functional proficiency in listening, speaking, reading and writing
3. Recognize culture-specific perspectives and values embedded in French language.

Expected Course Outcome:

The students will be able to :

1. Identify in French language the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations and interrogations.
2. Communicate effectively in French language via regular / irregular verbs.
3. Demonstrate comprehension of the spoken / written language in translating simple sentences.
4. Understand and demonstrate the comprehension of some particular new range of unseen written materials
5. Demonstrate a clear understanding of the French culture through the language studied

Module: 1	Expressions simples	3 hours

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc.

Savoir-faire pour:Saluer, Se présenter, Présenter quelqu'un, Etablir des contacts

Module: 2	La conjugaison des verbes réguliers	3 hours

La conjugaison des verbes réguliers, La conjugaison des verbes pronominaux, La Négation, L'interrogation avec 'Est-ce que ou sans Est-ce que'.

Savoir-faire pour:

Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.

Module: 3	La Nationalité du Pays, L'article (défini/ indéfini), Les prépositions	6 hours

La Nationalité du Pays, L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'article contracté, Les heures en français, L'adjectif (La Couleur, L'adjectif possessif, L'adjectif démonstratif/ L'adjectif interrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc.

Savoir-faire pour:

Poser des questions, Dire la date et les heures en français,

Module: 4	La traduction simple	4 hours

La traduction simple :(français-anglais / anglais –français),

Savoir-faire pour :

Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.

Module: 5	L'article Partitif, Mettez les phrases aux pluriels	5 hours

L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés, Trouvez les questions.

Savoir-faire pour :

Répondez aux questions générales en français, Exprimez les phrases données au Masculin ou au Féminin, Associez les phrases.		
Module: 6	**Décrivez :**	**3 hours**
Décrivez: La Famille / La Maison / L'université / Les Loisirs / La Vie quotidienne etc.		
Module: 7	Dialogue	**4 hours**
Dialogue: 1. Décrire une personne. 2. Des conversations à la cafeteria. 3. Des conversations avec les membres de la famille 4. Des dialogues entre les amis.		
Module: 8	**Guest lecures**	**2 hours**
Guest lectures / Natives speakers		
Total Lecture hours		**30 hours**

Text Book(s)	
1.	Fréquence jeunes-1, Méthode de français, G. Capelle et N.Gidon, Hachette, Paris, 2010.
2.	Fréquence jeunes-1, Cahier d'exercices, G. Capelle et N.Gidon, 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.	ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, Béatrix Sampsonis, Monique Waendendries, Hachette livre Paris 2011
4.	ALTER EGO 1, Le cahier d'activités, Annie Berthet, Catherine Hugo, Béatrix Sampsonis, Monique Waendendries, Hachette livre, Paris 2011

Mode of Evaluation: CAT / Assignment / Quiz / Seminar / FAT			
Recommended by Board of Studies	26.02.2016		
Approved by Academic Council	41st ACM	**Date**	17.06.2016

FRE2001	Français Progressif	L	T	P	J	C
		2	0	1	0	3

Pre-requisite	Français quotidien	Syllabus version
		1.0

Course Objectives:

The course gives students the necessary background to:

1. understand isolated sentences and frequently used expressions in relation to immediate priority areas (personal or family information, shopping, close environment, work).
2. communicate in simple and routine tasks requiring only a simple and direct exchange of information 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 passé récent : 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 compléments objets 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 sur les 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 etfrançaise – 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**	**2 hours**
Guest lecures/ Natives speakers		
	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			
Approved by Academic Council	No.41	Date	17.06.2016

GRE1001	Modern Greek	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	**NIL**	**Syllabus version**				
		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:

Students will be able:

1. To correctly pronounce Greek symbols and words, being more conscious and confident in the usage of their English vocabulary derived from Greek.
2. To make use of Modern Greek language in simple everyday conversation.
3. 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.
4. To be more aware about the evolution of Modern European languages, understanding the important connections between English and Greek/Neo-Latin languages.
5. 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**	**2**

Module content: 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.

alpha- 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**	**2, 11**

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**	**2, 11**

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**	**2, 11**

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**	**2, 11**
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**	**2**
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 αντικείμενο			
Written communication skills: describing weather conditions, defining time and date.			
Module:7	**Daily routine**	**3 hours**	**2, 11**
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**	**2, 11**
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	13.12.18

JAP1001	JAPANESE FOR BEGINNERS	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	Nil	Syllabus version				
		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 general etiquettes.
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	53rd ACM	**Date**	13.12.2018

STS1001	Introduction to Soft skills	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		2.0				

Course Objectives:

1. To enhance the ability to plan better and work as a team effectively
2. To boost the learning ability and to acquire analytical and research skills
3. To educate the habits required to achieve success

Expected Course Outcome:

1. Enabling students to know themselves and interact better with self and environment

Module:1	**Lessons on excellence**	**10 hours**

Ethics and integrity

Importance of ethics in life, Intuitionism vs Consequentialism, Non-consequentialism, Virtue ethics vs situation ethics, Integrity - listen to conscience, Stand up for what is right

Change management

Who moved my cheese?, Tolerance of change and uncertainty, Joining the bandwagon, Adapting change for growth - overcoming inhibition

How to pick up skills faster?

Knowledge vs skill, Skill introspection, Skill acquisition, "10,000 hours rule" and the converse

Habit formation

Know your habits, How habits work? - The scientific approach, How habits work? - The psychological approach, Habits and professional success, "The Habit Loop", Domino effect, Unlearning a bad habit

Analytic and research skills.

Focused and targeted information seeking, How to make Google work for you, Data assimilation

Module:2	**Team skills**	**11 hours**

Goal setting

SMART goals, Action plans, Obstacles -Failure management

Motivation

Rewards and other motivational factors, Maslow's hierarchy of needs, Internal and external motivation

Facilitation

Planning and sequencing, Challenge by choice, Full Value Contract (FVC), Experiential learning cycle, Facilitating the Debrief

Introspection

Identify your USP, Recognize your strengths and weakness, Nurture strengths, Fixing weakness, Overcoming your complex, Confidence building

Trust and collaboration

Virtual Team building, Flexibility, Delegating, Shouldering responsibilities

Module:3	Emotional Intelligence	12 hours

Transactional Analysis
Introduction**,** Contracting, Ego states**,** Life positions
Brain storming
Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming
Psychometric Analysis
Skill Test, Personality Test
Rebus Puzzles/Problem Solving
More than one answer, Unique ways

Module:4	Adaptability	12 hours

Theatrix
Motion Picture, Drama, Role Play, Different kinds of expressions
Creative expression
Writing, Graphic Arts, Music, Art and Dance
Flexibility of thought
The 5'P' framework (Profiling, prioritizing, problem analysis, problem solving, planning)
Adapt to changes(tolerance of change and uncertainty)
Adaptability Curve , Survivor syndrome

	Total Lecture hours:	45 hours	

Text Book(s)

1.	Chip Heath, How to Change Things When Change Is Hard (Hardcover),2010,First Edition,Crown Business.
2.	Karen Kindrachuk, Introspection**,** 2010, 1st Edition.
3.	Karen Hough, The Improvisation Edge: Secrets to Building Trust and Radical Collaboration at Work, 2011, Berrett-Koehler Publishers

Reference Books

1.	Gideon Mellenbergh, A Conceptual Introduction to Psychometrics: Development, Analysis and Application of Psychological and Educational Tests,2011, Boom Eleven International.
2.	Phil Lapworth, An Introduction to Transactional Analysis, 2011, Sage Publications (CA)

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

STS1002	Introduction to Business Communication	L	T	P	J	C
		3	0	0	0	1

Pre-requisite	None	Syllabus version
		2.0

Course Objectives:

1. To provide an overview of Prerequisites to Business Communication
2. To enhance the problem solving skills and improve the basic mathematical skills
3. To organize the thoughts and develop effective writing skills

Expected Course Outcome:

1. Enabling students enhance knowledge of relevant topics and evaluate the information

Module:1	Study skills	10 hours

Memory techniques

Relation between memory and brain, Story line technique, Learning by mistake, Image-name association, Sharing knowledge, Visualization

Concept map

Mind Map, Algorithm Mapping, Top down and Bottom Up Approach

Time management skills

Prioritization - Time Busters, Procrastination, Scheduling, Multitasking, Monitoring

6. Working under pressure and adhering to deadlines

Module:2	Emotional Intelligence (Self Esteem)	6 hours

Empathy

Affective Empathy and Cognitive Empathy

Sympathy

Level of sympathy (Spatial proximity, Social Proximity, Compassion fatigue)

Module:3	Business Etiquette	9 hours

Social and Cultural Etiquette

Value, Manners, Customs, Language, Tradition

Writing Company Blogs

Building a blog, Developing brand message, FAQs', Assessing Competition

Internal Communications

Open and objective Communication, Two way dialogue, Understanding the audience

Planning

Identifying, Gathering Information, Analysis, Determining, Selecting plan, Progress check, Types of planning

Writing press release and meeting notes

Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph, Body – Make it relevant to your audience

Module:4	**Quantitative Ability**	**4 hours**

Numeracy concepts

Fractions, Decimals, Bodmas, Simplifications, HCF, LCM, Tests of divisibility

Beginning to Think without Ink

Problems solving using techniques such as: Percentage, Proportionality, Support of answer choices, Substitution of convenient values, Bottom-up approach etc.

Math Magic

Puzzles and brain teasers involving mathematical concepts

Speed Calculations

Square roots, Cube roots, Squaring numbers, Vedic maths techniques

Module:5	**Reasoning Ability**	**3 hours**

Interpreting Diagramming and sequencing information

Picture analogy, Odd picture, Picture sequence, Picture formation, Mirror image and water image

Logical Links

Logic based questions-based on numbers and alphabets

Module:6	**Verbal Ability**	**3 hours**

S**trengthening Grammar Fundamentals**

Parts of speech, Tenses, Verbs(Gerunds and infinitives)

Reinforcements of Grammar concepts

Subject Verb Agreement, Active and Passive Voice, Reported Speech

Module:7	**Communication and Attitude**	**10 hours**

Writing

Writing formal & informal letters, How to write a blog & knowing the format, Effective ways of writing a blog, How to write an articles & knowing the format, Effective ways of writing an articles, Designing a brochures

Speaking skills

How to present a JAM, Public speaking

Self managing

Concepts of self management and self motivation, Greet and Know, Choice of words, Giving feedback, Taking criticism

	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	FACE, Aptipedia, Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, First Edition, McGraw-Hill Education Pvt. Ltd.
Reference Books	
1.	Alan Bond and Nancy Schuman, 300+ Successful Business Letters for All Occasions, 2010, Third Edition, Barron's Educational Series, New York.
2.	Josh Kaufman, The First 20 Hours: How to Learn Anything ... Fast , 2014, First Edition, Penguin Books, USA.
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)	

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

STS1101	Fundamentals of Aptitude	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

1. To enhance the logical reasoning skills of the students and improve the problem-solving abilities
2. To strengthen the ability to solve quantitative aptitude problems
3. To enrich the verbal ability of the students

Expected Course Outcome:

1. Students will be introduced to basic concepts of Quantitative Aptitude, Logical reasoning and Verbal ability
2. Students will be able to read and demonstrate good comprehension of text in areas of the student's interest
3. Students will be able to demonstrate the ability to resolve problems that occur in their field.

Module:1	**Lessons on excellence**	**2hours**

Skill introspection, Skill acquisition, consistent practice

Module:2	**Logical Reasoning**	**16 hours**

Thinking Skill

- Problem Solving
- Critical Thinking
- Lateral Thinking

Taught through thought-provoking word and rebus puzzles, and word-link builder questions

Coding & decoding, Series, Analogy, Odd man out and Visual reasoning

- Coding and Decoding
- Series
- Analogy
- Odd Man Out
- Visual Reasoning

Sudoku puzzles

Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers

Attention to detail

Picture and word driven Qs to develop attention to detail as a skill

Module:3	**Quantitative Aptitude**	**14 hours**

Speed Maths

- Addition and Subtraction of bigger numbers
- Square and square roots
- Cubes and cube roots
- Vedic maths techniques
- Multiplication Shortcuts
- Multiplication of 3 and higher digit numbers
- Simplifications
- Comparing fractions
- Shortcuts to find HCF and LCM
- Divisibility tests shortcuts

Algebra and functions

Module:4	**Recruitment Essentials**	**5hours**

Looking at an engineering career through the prism of an effective resume

- Importance of a resume - the footprint of a person's career achievements
- How a resume looks like?
- An effective resume vs. a poor resume: what skills you must build starting today and how?

Impression Management

Getting it right for the interview:

- Grooming, dressing
- Body Language and other non-verbal signs
- Displaying the right behaviour

Module:5	**Verbal Ability**	**8hours**

Essential grammar for placements:

- Nouns and Pronouns
- Verbs
- Subject-Verb Agreement
- Pronoun-Antecedent Agreement
- Punctuations

Verbal Reasoning

	Total Lecture hours:	**45 hours**

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition,

S. Chand Publishing, Delhi.			
Reference Book(s): Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.			
Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS1102	Arithmetic Problem Solving	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- To enhance the logical reasoning skills of the students and improve the problem-solving abilities
- To strengthen the ability to solve quantitative aptitude problems
- To enrich the verbal ability of the students for academic purpose

Expected course outcome:

- Students will be able to show more confidence in solving problems of Quantitative Aptitude
- Students will be able to show more confidence in solving problems of Logical Reasoning
- Students will be able to show more confidence in understanding the questions of Verbal Ability

Module:1	Logical Reasoning	11 hours

Word group categorization questions

Puzzle type class involving students grouping words into right group orders of logical sense

Cryptarithmetic

Data arrangements and Blood relations

- Linear Arrangement
- Circular Arrangement
- Multi-dimensional Arrangement
- Blood Relations

Module:2	Quantitative Aptitude	18 hours

Ratio and Proportion

- Ratio
- Proportion
- Variation
- Simple equations
- Problems on Ages
- Mixtures and alligations

Percentages, Simple and Compound Interest

- Percentages as Fractions and Decimals

- Percentage Increase / Decrease
- Simple Interest
- Compound Interest
- Relation Between Simple and Compound Interest

Number System

- Number system
- Power cycle
- Remainder cycle
- Factors, Multiples
- HCF and LCM

Module:3	**Verbal Ability**	**16hours**

Essential grammar for placements

- Prepositions
- Adjectives and Adverbs
- Tenses
- Forms and Speech and Voice
- Idioms and Phrasal Verbs
- Collocations, Gerund and Infinitives

Reading Comprehension for placements

- Types of questions
- Comprehension strategies
- Practice exercises

Articles, Prepositions and Interrogatives

- Definite and Indefinite Articles
- Omission of Articles
- Prepositions
- Compound Prepositions and Prepositional Phrases
- Interrogatives

Vocabulary for placements

- Exposure to solving questions of
- Synonyms
- Antonyms
- Analogy
- Confusing words
- Spelling correctness

	Total Lecture hours:	**45 hours**

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s):

Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS1201	Introduction to Problem Solving	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- To enhance the logical reasoning skills of the students and improve the problem-solving abilities
- To strengthen the ability to solve quantitative aptitude problems
- To enrich the verbal ability of the students for academic purpose

Expected Course Outcome:

- Students will be introduced to basic concepts of Quantitative Aptitude, Logical reasoning and Verbal ability
- Students will be able to read and demonstrate good comprehension of text in areas of the student's interest
- Students will be able to demonstrate the ability to resolve problems that occur in their field.

Module:1	**Lessons on excellence**	**2hours**

Skill introspection, Skill acquisition, consistent practice

Module:2	**Logical Reasoning**	**18 hours**

Thinking Skill

- Problem Solving
- Critical Thinking
- Lateral Thinking

Taught through thought-provoking word and rebus puzzles, and word-link builder questions

Coding & decoding, Series, Analogy, Odd man out and Visual reasoning

- Coding and Decoding
- Series
- Analogy
- Odd Man Out
- Visual Reasoning

Sudoku puzzles

Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers

Attention to detail

Picture and word driven Qs to develop attention to detail as a skill

Module:3	**Quantitative Aptitude**	**14 hours**

Speed Maths

- Addition and Subtraction of bigger numbers
- Square and square roots
- Cubes and cube roots
- Vedic maths techniques
- Multiplication Shortcuts
- Multiplication of 3 and higher digit numbers
- Simplifications
- Comparing fractions
- Shortcuts to find HCF and LCM
- Divisibility tests shortcuts

Algebra and functions

Module:4	**Recruitment Essentials**	**5hours**

Looking at an engineering career through the prism of an effective resume

- Importance of a resume - the footprint of a person's career achievements
- How a resume looks like?
- An effective resume vs. a poor resume: what skills you must build starting today and how?

Impression Management

Getting it right for the interview:

- Grooming, dressing
- Body Language and other non-verbal signs
- Displaying the right behaviour

Module:5	**Verbal Ability**	**6hours**

Grammar challenge

A practice paper with sentence based and passage-based questions on grammar discussed. Topics covered in questions are Nouns and Pronouns, Verbs, Subject-Verb Agreement, Pronoun-Antecedent Agreement, Punctuations

Verbal reasoning

	Total Lecture hours:	**45 hours**

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition,

S. Chand Publishing, Delhi.			
Reference Book(s): Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.			
Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS1202	Introduction to Quantitative, Logical and Verbal Ability	L	T	P	J	C
		3	0	0	0	1

Pre-requisite	None	Syllabus version
Cleared the cut-off in end-of-sem 1 assessment		1.0

Course Objectives:

- To enhance the logical reasoning skills of the students and improve the problem-solving abilities
- To strengthen the ability to solve quantitative aptitude problems
- To enrich the verbal ability of the students for academic purpose

Expected Course Outcome:

- Students will be able to show more confidence in solving problems of Quantitative Aptitude
- Students will be able to show more confidence in solving problems of Logical Reasoning
- Students will be able to show more confidence in understanding the questions of Verbal Ability

Module:1	Logical Reasoning	12 hours

Word group categorization questions

Puzzle type class involving students grouping words into right group orders of logical sense

Cryptarithmetic

Data arrangements and Blood relations

- Linear Arrangement
- Circular Arrangement
- Multi-dimensional Arrangement
- Blood Relations

Module:2	Quantitative Aptitude	20 hours

Ratio and Proportion

- Ratio
- Proportion
- Variation
- Simple equations
- Problems on Ages
- Mixtures and alligations: Problems involving multiple iterations of mixtures

Percentages, Simple and Compound Interest

- Percentages as Fractions and Decimals
- Percentage Increase / Decrease
- Simple Interest
- Compound Interest
- Relation Between Simple and Compound Interest

Number System

- Number system
- Power cycle
- Remainder cycle
- Factors, Multiples
- HCF and LCM

Module:3	**Verbal Ability**	**13 hours**

Reading Comprehension – Advanced

Grammar - application and discussion

A practice paper with sentence based and passage-based questions on grammar discussed. Topics covered in questions are Prepositions, Adjectives and Adverbs, Tenses, Forms and Speech and Voice, Idioms and Phrasal Verbs, Collocations, Gerund and Infinitives

Articles, Prepositions and Interrogatives

- Definite and Indefinite Articles
- Omission of Articles
- Prepositions
- Compound Prepositions and Prepositional Phrases
- Interrogatives

Vocabulary – Advanced

Exposure to challenging placement questions on vocabulary

	Total Lecture hours:	**45 hours**

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s): Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.			
Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS2001	Reasoning Skill Enhancement	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		2.0				

Course Objectives:

1. To strengthen the social network by the effective use of social media and social interactions.
2. To identify own true potential and build a very good personal branding
3. To enhance the Analytical and reasoning skills.

Expected Course Outcome:

1. Understanding the various strategies of conflict resolution among peers and supervisors and respond appropriately

Module:1	**Social Interaction and Social Media**	**6 hours**

Effective use of social media

Types of social media, Moderating personal information, Social media for job/profession, Communicating diplomatically

Networking on social media

Maximizing network with social media, How to advertise on social media

Event management

Event management methods, Effective techniques for better event management

Influencing

How to win friends and influence people, Building relationships, Persistence and resilience, Tools for talking when stakes are high

Conflict resolution

Definition and strategies ,Styles of conflict resolution

Module:2	**Non Verbal Communication**	**6 hours**

Proximecs

Types of proximecs**,** Rapport building

Reports and Data Transcoding

Types of reports

Negotiation Skill

Effective negotiation strategies

Conflict Resolution

Types of conflicts

Module:3	**Interpersonal Skill**	**8 hours**

Social Interaction

Interpersonal Communication,Peer Communication, Bonding,Types of social interaction

Responsibility

Types of responsibilities**,** Moral and personal responsibilities

Networking

Competition, Collaboration, Content sharing

Personal Branding

Image Building, Grooming, Using social media for branding

Delegation and compliance

Assignment and responsibility, Grant of authority, Creation of accountability

Module:4	**Quantitative Ability**	**10 hours**

Number properties

Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position

Averages

Averages, Weighted Average

Progressions

Arithmetic Progression, Geometric Progression, Harmonic Progression

Percentages

Increase & Decrease or successive increase

Ratios

Types of ratios and proportions

Module:5	**Reasoning Ability**	**8 hours**

Analytical Reasoning

Data Arrangement(Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzletest, Selection Decision table

Module:6	**Verbal Ability**	**7 hours**

Vocabulary Building

Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies

	Total Lecture hours:	**45 hours**	

Text Book(s)

1.	FACE, Aptipedia Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, First Edition, McGraw-Hill Education Pvt.Ltd.
3.	Mark G. Frank, David Matsumoto, Hyi Sung Hwang, Nonverbal Communication: Science and Applications, 2012, 1st Edition, Sage Publications, New York.

Reference Books

1.	Arun Sharma, Quantitative aptitude, 2016, 7th edition, Mcgraw Hill Education Pvt. Ltd.

2.	Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler, Crucial Conversations: Tools for Talking When Stakes are High, 2001,1st edition McGraw Hill Contemporary, Bangalore.		
3.	Dale Carnegie, How to Win Friends and Influence People, Latest Edition,2016. Gallery Books, New York.		
Mode of evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

STS2002	Introduction to Etiquette	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		2.0				

Course Objectives:

1. To analyze social psychological phenomena in terms of impression management.
2. To control or influence other people's perceptions.
3. To enhance the problem solving skills

Expected Course Outcome:

Creating in the students an understanding of decision making models and generating alternatives using appropriate expressions.

Module:1	**Impression Management**	**8 hours**

Types and techniques

Importance of impression management, Types of impression management, Techniques and case studies, Making a good first impression in an interview (TEDOS technique) , How to recover from a bad impressions/experience, Making a good first impression online

Non-verbal communication and body language

Dressing, Appearance and Grooming, Facial expression and Gestures, Body language (Kinesics), Keywords to be used, Voice elements (tone, pitch and pace)

Module:2	**Thinking Skills**	**4 hours**

Introduction to problem solving process

Steps to solve the problem, Simplex process

Introduction to decision making and decision making process

Steps involved from identification to implementation**,** Decision making model

Module:3	**Beyond Structure**		**4 hours**

Art of questioning
How to frame questions, Blooms questioning pyramid, Purpose of questions
Etiquette
Business, Telephone etiquette, Cafeteria etiquette, Elevator etiquette, Email etiquette, Social media etiquette

Module:4	**Quantitative Ability**	**9 hours**

Profit and Loss
Cost Price & Selling Price, Margins & Markup
Interest Calculations
Simple Interest, Compound Interest, Recurring
Mixtures and solutions
Ratio & Averages, Proportions
Time and Work
Pipes & Cisterns, Man Day concept, Division Wages
Time Speed and Distance
Average speed, Relative speed, Boats and streams.

Proportions & Variations

Module:5	**Reasoning Ability**	**11 hours**

Logical Reasoning
Sequence and series, Coding and decoding, Directions
Visual Reasoning
Abstract Reasoning, Input Type Diagrammatic Reasoning, Spatial reasoning, Cubes
Data Analysis And Interpretation
DI-Tables/Charts/Text

Module:6	**Verbal Ability**	**9 hours**

Grammar
Spot the Errors, Sentence Correction, Gap Filling Exercise, Sentence Improvisations, Misc. Grammar Exercise

	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	Micheal Kallet, Think Smarter: Critical Thinking to Improve Problem-Solving and Decision-Making Skills, April 7, 2014, 1st Edition, Wiley, New Jersey.
2.	MK Sehgal, Business Communication, 2008, 1st Edition, Excel Books, India.
3.	FACE, Aptipedia Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.
4.	ETHNUS, Aptimithra, 2013, First edition, McGraw-Hill Education Pvt. Ltd, Banglore.
Reference Books	
1.	Andrew J. DuBrin, Impression Management in the Workplace: Research, Theory and Practice, 2010, 1st edition, Routledge.
2.	Arun Sharma, Manorama Sharma, Quantitative aptitude, 2016, 7th edition, McGraw Hill Education Pvt. Ltd, Banglore.
3.	M. Neil Browne, Stuart M. Keeley, Asking the right questions, 2014, 11th Edition, Pearson, London.
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)	

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

STS2101	Getting Started to Skill Enhancement	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- To develop the students' logical thinking skills and apply it in the real-life scenarios
- To learn the strategies of solving quantitative ability problems
- To enrich the verbal ability of the students

Expected Course Outcome:

- Students will be able to demonstrate critical thinking skills, such as problem solving related to their subject matters
- Students will be able to demonstrate competency in verbal, quantitative and reasoning aptitude
- Students will be able to perform good written communication skills

Module:1	**Logical Reasoning**	**11 hours**

Clocks, calendars, Direction sense and Cubes

- Clocks
- Calendars
- Direction Sense
- Cubes

Data interpretation and Data sufficiency

- Data Interpretation – Tables
- Data Interpretation - Pie Chart
- Data Interpretation - Bar Graph
- Data Sufficiency

Module:2	**Quantitative Aptitude**	**18 hours**

Time and work

- Work with different efficiencies
- Pipes and cisterns
- Work equivalence
- Division of wages

Time, Speed and Distance

- Basics of time, speed and distance
- Relative speed
- Problems based on trains
- Problems based on boats and streams
- Problems based on races

Profit and loss, Partnerships and averages

- Basic terminologies in profit and loss
- Partnership
- Averages
- Weighted average

Module:3	**Verbal Ability**	**13hours**

Sentence Correction

- Subject-Verb Agreement
- Modifiers
- Parallelism
- Pronoun-Antecedent Agreement
- Verb Time Sequences
- Comparisons
- Prepositions
- Determiners

Sentence Completion and Para-jumbles

- Pro-active thinking
- Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues)
- Fixed jumbles
- Anchored jumbles

Module:4	**Writing skills for placements**	**3 hours**

Essay writing

- Idea generation for topics
- Best practices
- Practice and feedback

	Total Lecture hours:	**45 hours**

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s):

Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS2102	Enhancing Problem Solving Skills	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- To develop the students' logical thinking skills and apply it in the real-life scenarios
- To learn the strategies of solving quantitative ability problems
- To enrich the verbal ability of the students
- To strengthen the basic programming skills for placements

Expected Course Outcome:

- The students will be able to interact confidently and use decision making models effectively
- The students will be able to deliver impactful presentations
- The students will be able to be proficient in solving quantitative aptitude and verbal ability questions effortlessly

Module:1	**Logical Reasoning**	**5 hours**

Logical connectives, Syllogism and Venn diagrams

- Logical Connectives
- Syllogisms
- Venn Diagrams – Interpretation

Venn Diagrams – Solving

Module:2	**Quantitative Aptitude**	**11 hours**

Logarithms, Progressions, Geometry and Quadratic equations

- Logarithm
- Arithmetic Progression
- Geometric Progression
- Geometry
- Mensuration
- Coded inequalities
- Quadratic Equations

Permutation, Combination and Probability

- Fundamental Counting Principle
- Permutation and Combination
- Computation of Permutation
- Circular Permutations
- Computation of Combination

Probability

Module:3	**Verbal Ability**	**4 hours**

Critical Reasoning

- Argument – Identifying the Different Parts (Premise, assumption, conclusion)
- Strengthening statement
- Weakening statement
- Mimic the pattern

Module:4	**Recruitment Essentials**	**7 hours**

Cracking interviews - demonstration through a few mocks

Sample mock interviews to demonstrate how to crack the:

- HR interview
- MR interview
- Technical interview

Cracking other kinds of interviews

- Skype/ Telephonic interviews
- Panel interviews
- Stress interviews

Resume building – workshop

A workshop to make students write an accurate resume

Module:5	**Problem solving and Algorithmic skills**	**18 hours**

- Logical methods to solve problem statements in Programming
- Basic algorithms introduced

	Total Lecture hours:	**45 hours**

Mode of Evaluation: FAT, Assignments, Mock interviews, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s):

Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS2201	Numerical Ability and Cognitive Intelligence	L	T	P	J	C
		3	0	0	0	1

Pre-requisite	None	Syllabus version
		1.0

Course Objectives:

- To develop the students' logical thinking skills and apply it in the real-life scenarios
- To learn the strategies of solving quantitative ability problems
- To enrich the verbal ability of the students

Expected Course Outcome:

- Students will be able to demonstrate critical thinking skills, such as problem solving related to their subject matters
- Students will be able to demonstrate competency in verbal, quantitative and reasoning aptitude
- Students will be able to perform good written communication skills

Module:1	Logical Reasoning	10 hours

Clocks, calendars, Direction sense and Cubes

- Clocks
- Calendars
- Direction Sense
- Cubes

Practice on advanced problems

Data interpretation and Data sufficiency - Advanced

- Advanced Data Interpretation and Data Sufficiency questions of CAT level
- Multiple chart problems
- Caselet problems

Module:2	Quantitative Aptitude	19 hours

Time and work – Advanced

- Work with different efficiencies
- Pipes and cisterns: Multiple pipe problems
- Work equivalence
- Division of wages
- Advanced application problems with complexity in calculating total work

Time, Speed and Distance - Advanced

- Relative speed
- Advanced Problems based on trains
- Advanced Problems based on boats and streams

- Advanced Problems based on races

Profit and loss, Partnerships and averages - Advanced

- Partnership
- Averages
- Weighted average

Advanced problems discussed

Number system - Advanced

Advanced application problems on Numbers involving HCF, LCM, divisibility tests, remainder and power cycles.

Module:3	**Verbal Ability**	**13 hours**

Sentence Correction - Advanced

- Subject-Verb Agreement
- Modifiers
- Parallelism
- Pronoun-Antecedent Agreement
- Verb Time Sequences
- Comparisons
- Prepositions
- Determiners

Quick introduction to 8 types of errors followed by exposure to GMAT level questions

Sentence Completion and Para-jumbles - Advanced

- Pro-active thinking
- Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues)
- Fixed jumbles
- Anchored jumbles

Practice on advanced GRE/ GMAT level questions

Reading Comprehension – Advanced

Exposure to difficult foreign subject-based RCs of the level of GRE/ GMAT

Module:4	**Writing skills for placements**	**3 hours**		

Essay writing

- Idea generation for topics
- Best practices
- Practice and feedback

	Total Lecture hours:	**45 hours**

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s):

Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS2202	Advanced Aptitude and Reasoning Skills	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

1. To develop the students' logical thinking skills and apply it in the real-life scenarios
2. To learn the strategies of solving quantitative ability problems
3. To enrich the verbal ability of the students
4. To strengthen the basic programming skills for placements

Expected Course Outcome:

- The students will be able to interact confidently and use decision making models effectively
- The students will be able to deliver impactful presentations
- The students will be able to be proficient in solving quantitative aptitude and verbal ability questions effortlessly

Module:1	**Logical Reasoning**	**4 hours**

Logical Reasoning puzzles - Advanced

Advanced puzzles:

1. Sudoku
2. Mind-bender style word statement puzzles
3. Anagrams
4. Rebus puzzles

Logical connectives, Syllogism and Venn diagrams

1. Logical Connectives
2. Advanced Syllogisms - 4, 5, 6 and other multiple statement problems
3. Challenging Venn Diagram questions: Set theory

Module:2	**Quantitative Aptitude**	**10 hours**

Logarithms, Progressions, Geometry and Quadratic equations - Advanced

1. Logarithm
2. Arithmetic Progression
3. Geometric Progression
4. Geometry
5. Mensuration
6. Coded inequalities
7. Quadratic Equations

Concepts followed by advanced questions of CAT level

Permutation, Combination and Probability - Advanced

- Fundamental Counting Principle
- Permutation and Combination
- Computation of Permutation - Advanced problems
- Circular Permutations
- Computation of Combination - Advanced problems
- Advanced probability

Module:3	Verbal Ability	5 hours

Image interpretation

1. Image interpretation: Methods
2. Exposure to image interpretation questions through brainstorming and practice

Critical Reasoning - Advanced

1. Concepts of Critical Reasoning
2. Exposure to advanced questions of GMAT level

Module:4	Recruitment Essentials	8 hours

Mock interviews

Cracking other kinds of interviews

Skype/ Telephonic interviews
Panel interviews
Stress interviews

Guesstimation

1. Best methods to approach guesstimation questions
2. Practice with impromptu interview on guesstimation questions

Case studies/ situational interview

1. Scientific strategies to answer case study and situational interview questions
2. Best ways to present cases
3. Practice on presenting cases and answering situational interviews asked in recruitment rounds

Module:5	Problem solving and Algorithmic skills	18 hours

1. Logical methods to solve problem statements in Programming
2. Basic algorithms introduced

	Total Lecture hours:	45 hours

Mode of Evaluation: FAT, Assignments, Mock interviews, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.

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ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.
R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

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<tr><td colspan="4">Reference Book(s):
Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.</td></tr>
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<tr><td>Approved by Academic Council</td><td>No. 53rd AC</td><td>Date</td><td>13.12.2018</td></tr>
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STS3001	Preparedness for External Opportunities	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		2.0				

Course Objectives:

1. To effectively tackle the interview process, and leave a positive impression with your prospective employer by reinforcing your strength, experience and appropriateness for the job.
2. To check if candidates have the adequate writing skills that are needed in an organization.
3. To enhance the problem solving skills.

Expected Course Outcome:

1. Enabling students acquire skills for preparing for interviews, presentations and higher education

Module:1	Interview Skills	3 hours

Types of interview

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview

Techniques to face remote interviews

Video interview, Recorded feedback , Phone interview preparation

Mock Interview

Tips to customize preparation for personal interview, Practice rounds

Module:2	Resume Skills	2 hours

Resume Template

Structure of a standard resume**,** Content, color, font

Use of power verbs

Introduction to Power verbs and Write up

Types of resume

Quiz on types of resume

Customizing resume

Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

Module:3	Presentation Skills	6 hours

Preparing presentation

10 tips to prepare PowerPoint presentation**,** Outlining the content, Passing the Elevator Test

Organizing materials

Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation

Maintaining and preparing visual aids

Importance and types of visual aids, Animation to captivate your audience, Design of posters

Dealing with questions

Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:4	**Quantative Ability**	**14 hours**

Permutation-Combinations

Counting, Grouping, Linear Arrangement, Circular Arrangements

Probability

Conditional Probability, Independent and Dependent Events

Geometry and Mensuration

Properties of Polygon, 2D & 3D Figures, Area & Volumes

Trigonometry

Heights and distances, Simple trigonometric functions

Logarithms

Introduction, Basic rules

Functions

Introduction, Basic rules

Quadratic Equations

Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations

Set Theory

Basic concepts of Venn Diagram

Module:5	**Reasoning Ability**	**7 hours**

Logical reasoning

Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic

Data Analysis and Interpretation

Data Sufficiency

Data interpretation-Advanced Interpretation tables, pie charts & bar chats

Module:6	**Verbal Ability**	**8 hours**

Comprehension and Logic

Reading comprehension

Para Jumbles

Critical Reasoning :

Premise and Conclusion, Assumption & Inference, Strengthening & Weakening an Argument

Module:7	**Writing Skills**	**5 hours**

Note making

What is note making, Different ways of note making

Report writing

What is report writing, How to write a report, Writing a report & work sheet **Product description** Designing a product, Understanding it's features, Writing a product description **Research paper** Research and its importance, Writing sample research paper			
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	Michael Farra, Quick Resume & Cover letter Book, 2011, 1st Edition, JIST Editors, Saint Paul.
2.	Daniel Flage, An Introduction to Critical Thinking, 2002, 1st Edition, Pearson, London.
Reference Books	
1.	FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt. Ltd.

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

STS3004	Data Structures and Algorithms	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

1. To assess how the choice of data structures and algorithm design methods impacts the performance of programs.
2. To develop logics which will help them to create programs, applications in C.
3. To learn how to design a graphical user interface (GUI) with Java Swing.

Expected Course Outcome:

1. Clear knowledge about problem solving skills in DS & Algorithms concepts

Module:1	**Data Structures**	**10 hours**

Introduction to data structures, Array, Linked List, Stack, Queue, Trees.

Module:2	**Algorithms**	**15 hours**

Introduction to Algorithms, Searching Algorithms, Sorting Algorithms, Greedy Algorithm, Divideand Conquer, Analysis of Algorithm.

Module:3	**C Programming**	**10 hours**

Introduction to C, Execution and Structure of a C Program, Data Types and Operators, Control Statements, Looping, Arrays, Structure, Pointers, Memory Management in C, Functions

Module:4	**C++ Programming**	**5 hours**

Introduction to C++, Need for OOP, Class & Objects, Create C++ & Java class and show the similarity Encapsulation, Access Specifiers, Relationship, Polymorphism, Exception Handling,Abstract Classes**.**

Module:5	**JAVA**	**5 hours**

Introduction to Java, Data Types and Operators, Control Statements, Looping, Arrays, Need forOOP, Class & Objects, Create C++ & Java class and show the similarity Encapsulation, Access Specifiers, Relationship, Polymorphism, Exception Handling, Abstract Classes, Interfaces.

	Total Lecture hours:	**45 hours**	

Reference Books

1.	Data Structures and Algorithms: https://ece.uwaterloo.ca/~dwharder/aads/Lecture_materials/: University of waterloo
2.	C Programming: C Programming Absolute Beginner's Guide (3rd Edition) by Greg Perry, Dean Miller
3.	Java: Thinking in Java, 4th Edition

Mode of Evaluation: FAT, Assignments, Projects, 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

STS3005	Code Mithra	L	T	P	J	C
		3	0	0	0	1

Pre-requisite	None	Syllabus version
		1.0

Course Objectives:

1. To develop logics which will help them to create programs, applications in C.
2. To learn how to design a graphical user interface (GUI) with Java Swing.
3. To present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively.

Expected Course Outcome:

1. Enabling students to write coding in C,C++,Java and DBMS concepts

Module:1	C Programming	15 hours

Introduction to C, Execution and Structure of a C Program, Data Types and Operators, Control Statements, Looping, Arrays, Structure, Pointers, Memory Management in C, Functions.

Module:2	C++ Programming	15 hours

Introduction to C++, Need for OOP, Class & Objects, Create C++ & Java class and show the similarity Encapsulation, Access Specifiers, Relationship, Polymorphism, Exception Handling, Abstract Classes, Interfaces.

Module:3	JAVA	10 hours

Introduction to Java, Data Types and Operators, Control Statements, Looping, Arrays, Need for OOP, Class & Objects, Create C++ & Java class and show the similarity Encapsulation, Access Specifiers, Relationship, Polymorphism, Exception Handling, Abstract Classes, Interfaces.

Module:4	Database	5 hours

Introduction to database, DDL, Data Manipulation, SELECT, Joins.

	Total Lecture hours:	45 hours	

Reference Books

1.	Data Structures and Algorithms: https://ece.uwaterloo.ca/~dwharder/aads/Lecture_materials/
2.	C Programming: C Programming Absolute Beginner's Guide (3rd Edition) by Greg Perry, Dean Miller
3.	Java: Thinking in Java, 4th Edition
4.	**Websites: www.eguru.ooo**

Mode of Evaluation: FAT, Assignments, Projects 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No.45th AC	Date	15/06/2017

STS3006	Preparedness for External Opportunities	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

1.To enhance the problem solving skills.
2.To check if candidates have the adequate writing skills that are needed in an organization.
3. To reason, model, and draw conclusions or make decisions with mathematical, statistical, and quantitative information.

Expected Course Outcome:

1. Students will be able to solve mathematical, reasoning and verbal questionnaires

Module:1	Quantitative Ability	12 hours

Time and Work, Time Speed and Distance, Number System, Equations, Percentages, Profit and Loss, Permutation and Combination, Probability, Geometry and Mensuration, Averages, Progression, Allegations and Mixtures, Ages

Module:2	Reasoning Ability	12 hours

Data Arrangement - Linear, Circular and Cross Variable Relationship**,** Data Sufficiency, Data Interpretation-Advanced Interpretation Tables**,** Coding and Decoding, Abstract Reasoning, Input Type Diagrammatic Reasoning, Spatial Reasoning, Cubes, Clocks and Calendar

Module:3	Verbal Ability	21 hours

Vocabulary Building
Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies, Cloze Test.
Comprehension and Logic
Reading comprehension
Para Jumbles
Critical Reasoning
Premise and Conclusion, Assumption & Inference, Strengthening & Weakening an Argument.
Sentence Correction
Modifiers, parallelism, Verb time sequences, Comparison, Determiners.
Building personal lexicon
Benefits of becoming a logophile, Etymology – Root words, Prefix and suffix.
Grammar
Spot the Errors, Sentence Correction, Gap Filling Exercise.

Text Book(s)

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.

3.	R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.		
Reference Books			
1.	Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.		
Mode of evaluation: Assignments, Projects, Case studies, FAT (Computer Based Test)			
Recommended by Board of Studies			
Approved by Academic Council	No.49	Date	15/03/2018

STS3007	Preparedness for Career Opportunities	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

1. To enrich the logical thinking ability for better analysis and decision making
2. To hone the competence in solving problems and reasoning skills
3. To build a good vocabulary and use it in effective communication

Expected Course Outcome:

1. Students will be able to solve mathematical, reasoning and verbal questionnaires

Module:1	**Quantitative Ability**	**15 hours**

Time and Work, Time Speed and Distance, Number System, Equations, Percentages, Profit and Loss, Permutation and Combination, Probability, Geometry and Mensuration, Averages, Progression, Allegations and Mixtures, Ages

Module:2	**Reasoning Ability**	**12 hours**

Data Arrangement - Linear, Circular and Cross Variable Relationship**,** Data Sufficiency, Data Interpretation-Advanced Interpretation Tables**,** Coding and Decoding, Abstract Reasoning, Input Type Diagrammatic Reasoning, Spatial Reasoning, Cubes, Clocks and Calendar

Module:3	**Verbal Ability**	**18 hours**

Vocabulary Building

Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies, Cloze Test.

Comprehension and Logic

Reading comprehension

Para Jumbles

Critical Reasoning :

Premise and Conclusion, Assumption & Inference, Strengthening & Weakening an Argument.

Sentence Correction

Modifiers, parallelism, Verb time sequences, Comparison, Determiners.

Building personal lexicon

Benefits of becoming a logophile, Etymology – Root words, Prefix and suffix.

Text Book(s)

1.	FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3.	R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Books			
1.	Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.		
Mode of evaluation: Assignments, Projects, Case studies, FAT (Computer Based Test)			
Recommended by Board of Studies			
Approved by Academic Council	No.49	Date	15/03/2018

STS3101	Introduction to Programming Skills	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem solving skills in JAVA concepts
- Students will be able to write codes in Java

Module:1	**Object and Class, Data types**	**8 hours**

Types of programming
Disadvantages of functional programming
Class & Objects
Attributes
Methods
Objects
Solving MCQs based on Objects and Classes
Solving tricky questions based on encapsulation
Solving frequently asked object-based questions

Data types
Data
Why data type
Variables
Available data types
Numeric – int, float, double
Character – char, string
Solving MCQs based on type casting, data types
Solving debugging based MCQs

Module:2	**Basic I / O, Decision Making, Loop Control**	**8 hours**

Printing
Getting input from user during run time
Command line arguments
Solving programming questions based on CLA
Solving MCQs questions based on CLA

Need for control statement
if..else
if..else if..else
Nested if..else
Switch case
Common mistakes with control statements (like using = instead of ==)
Solving frequently asked questions on decision making

Types of looping statements
Entry Controlled
For
While
Exit Controlled
do while
break and continue
Demo on looping
Common mistakes with looping statements (like using; at the end of the loop)
Solving pattern programming problems, series problems
Solving predict the output questions

Module:3	**String, Date, Array**	**10 hours**

String handling, date handling
Solving problems based on arrays like searching, sorting, rearranging, iteration)
Multi-dimensional arrays
Solving pattern problems using 2D arrays
Real time application based on 2D arrays

Module:4	**Inheritance, Aggregation & Associations**	**12 hours**

Need
Is A – Inheritance
Types of inheritance supported
Diagrammatic representation
Demo on inheritance
Has A – Aggregation
Diagrammatic representation
Demo on aggregation
Uses A - Association
Diagrammatic representation
Demo on association
Assignment on relationships
Solving MCQs based on relationships between classes

Module:5	**Modifiers, Interface & Abstract classes (Java specific), Packages**	**7 hours**

Types of access specifiers
Demo on access specifiers

Assignment on access modifiers Instance Members Solving MCQs based on modifiers Abstract Classes Need Abstract Classes Abstract Methods Interfaces Assignment on abstract classes and interface Need for packages Access specifiers & packages Import classes from other packages			
	Total Lecture hours:		**45 hours**
Reference Books			
1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd		
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean		
Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS3104	Enhancing Programming Ability	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem solving skills in JAVA concepts
- Students will be able to write codes in Java

Module:1	**Collections**	**12 hours**

ArrayList, LinkedList, List Interface, HashSet, Map Interface, HashMap, Set
Programming questions based on collections
Real world problems based on data structure

Module:2	**Threads, Exceptions, LinkedList, Arrays**	**6 hours**

Need of threads
Creating threads
Wait
Sleep
Thread execution

Need for exception handling
try, catch, throw, throws
Creating own exception (Java, Python)
Handling own exceptions

Solving programming questions based on linked list and arrays

Module:3	**Stack and Queue, Trees**	**7 hours**

Solving programming questions based on stacks and queues
How to implement a stack using queue?
How to implement a queue using stack?

Solving programming questions based on trees, binary trees, binary search trees

Module:4	**JDBC Connectivity, JDBC Data**	**10 hours**

JDBC Overview
Database Setup

Install the MySQL Database Create New Database User in MySQL Workbench Selecting data from tables Inserting Data into the Database Updating Data in the Database Deleting Data from the Database Creating Prepared Statements		
Module:5	**Networking with Java**	**10 hours**
Working with URLs Sending HTTP Requests Processing JSON data using Java Processing XML data using Java		
	Total Lecture hours:	**45 hours**

Reference Books	
1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS3105	Computational Thinking	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem solving skills in JAVA concepts
- Students will be able to write codes in Java

Module:1	**Date, Array**	**10 hours**

date handling
Solving problems based on arrays like searching, sorting, rearranging, iteration)
Multi-dimensional arrays
Solving pattern problems using 2D arrays
Real time application based on 2D arrays

Module:2	**Inheritance, Aggregation & Associations**	**15 hours**

Need
Is A – Inheritance
Types of inheritance supported
Diagrammatic representation
Demo on inheritance
Has A – Aggregation
Diagrammatic representation
Demo on aggregation
Uses A - Association
Diagrammatic representation
Demo on association
Assignment on relationships
Solving MCQs based on relationships between classes

Module:3	**Modifiers, Interface & Abstract classes (Java specific)**	**10 hours**

Types of access specifiers
Demo on access specifiers
Assignment on access modifiers
Instance Members
Solving MCQs based on modifiers

Abstract Classes Need Abstract Classes Abstract Methods Interfaces Assignment on abstract classes and interface		
Module:4	**Packages**	**5 hours**
Need for packages Access specifiers & packages Import classes from other packages		
Module:5	**Exceptions**	**5 hours**
Need for exception handling try, catch, throw, throws Creating own exception (Java, Python) Handling own exceptions		
	Total Lecture hours:	**45 hours**

Reference Books	
1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS3201	Programming Skills for Employment	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem solving skills in JAVA concepts
- Students will be able to write codes in Java

Module:1	**Object and Class, Data types, Basic I / O**	**8 hours**

Types of programming
Disadvantages of functional programming
Class & Objects
Attributes
Methods
Objects
Solving MCQs based on Objects and Classes
Solving tricky questions based on encapsulation
Solving frequently asked object based questions

Data types
Data
Why data type
Variables
Available data types
Numeric – int, float, double
Character – char, string
Solving MCQs based on type casting, data types
Solving debugging based MCQs

Printing
Getting input from user during run time
Command line arguments
Solving programming questions based on CLA
Solving MCQs questions based on CLA

Module:2	Decision Making, Loop Control, String, Date, Array	10 hours

Need for control statement
if..else
if..else if..else
Nested if..else
Switch case
Common mistakes with control statements (like using = instead of ==)
Solving frequently asked questions on decision making

Types of looping statements
Entry Controlled
For
While
Exit Controlled
do while
break and continue
Demo on looping
Common mistakes with looping statements (like using ; at the end of the loop)
Solving pattern programming problems, series problems
Solving predict the output questions

String handling, date handling
Solving problems based on arrays like searching, sorting, rearranging, iteration)
Multi-dimensional arrays
Solving pattern problems using 2D arrays
Real time application based on 2D arrays

Module:3	Inheritance, Aggregation & Associations	10 hours

Need
Is A – Inheritance
Types of inheritance supported
Diagrammatic representation
Demo on inheritance
Has A – Aggregation
Diagrammatic representation
Demo on aggregation
Uses A - Association
Diagrammatic representation
Demo on association
Assignment on relationships
Solving MCQs based on relationships between classes

Module:4	Modifiers, Interface & Abstract classes (Java specific), Packages	7 hours

Types of access specifiers

Demo on access specifiers Assignment on access modifiers Instance Members Solving MCQs based on modifiers Abstract Classes Need Abstract Classes Abstract Methods Interfaces Assignment on abstract classes and interface Need for packages Access specifiers & packages Import classes from other packages		
Module:5	**Collections**	**10 hours**
ArrayList, LinkedList, List Interface, HashSet, Map Interface, HashMap, Set Programming questions based on collections Real world problems based on data structure		
	Total Lecture hours:	**45 hours**

Reference Books	
1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS3204	JAVA Programming and Software Engineering Fundaments	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem solving skills in JAVA concepts
- Students will be able to write codes in Java

Module:1	**Threads, Exceptions, LinkedList, Arrays, Stack and Queue**	**8 hours**

Need of threads
Creating threads
Wait
Sleep
Thread execution

Need for exception handling
try, catch, throw, throws
Creating own exception (Java, Python)
Handling own exceptions

Solving programming questions based on linked list and arrays

Solving programming questions based on stacks and queues
How to implement a stack using queue?
How to implement a queue using stack?

Module:2	**Trees, JDBC Connectivity**	**7 hours**

Solving programming questions based on trees, binary trees, binary search trees
JDBC Overview
Database Setup
Install the MySQL Database
Create New Database User in MySQL Workbench

Module:3	**JDBC Data**	**6 hours**

Selecting data from tables Inserting Data into the Database Updating Data in the Database Deleting Data from the Database Creating Prepared Statements		
Module:4	**Networking with Java**	**12 hours**
Working with URLs Sending HTTP Requests Processing JSON data using Java Processing XML data using Java		
Module:5	**Advanced programming**	**12 hours**
File Operations CSV Operations Encoder & Decoders Encryption & Decryption Hashes Loggers		
	Total Lecture hours:	**45 hours**

Reference Books	
1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS3205	Advanced JAVA Programming	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem solving skills in JAVA concepts
- Students will be able to write codes in Java

Module:1	**Associations, Modifiers**	**9 hours**

Uses A - Association
Diagrammatic representation
Demo on association
Assignment on relationships
Solving MCQs based on relationships between classes

Types of access specifiers
Demo on access specifiers
Assignment on access modifiers
Instance Members
Solving MCQs based on modifiers

Module:2	**Interface & Abstract classes (Java specific), Packages**	**10 hours**

Abstract Classes
Need
Abstract Classes
Abstract Methods
Interfaces
Assignment on abstract classes and interface

Need for packages
Access specifiers & packages
Import classes from other packages

Module:3	**Exceptions**	**7 hours**

Need for exception handling
try, catch, throw, throws

Creating own exception (Java, Python) Handling own exceptions			
Module:4	**Collections**		**15 hours**
ArrayList, LinkedList, List Interface, HashSet, Map Interface, HashMap, Set Programming questions based on collections Real world problems based on data structure			
Module:5	**LinkedList, Arrays**		**4 hours**
Solving programming questions based on linked list and arrays			
	Total Lecture hours:		**45 hours**
Reference Books			
1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd		
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean		
Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS3301	JAVA for Beginners	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem solving skills in JAVA concepts
- Students will be able to write codes in Java

Module:1	**Introduction to Programming**	**10 hours**

Introduction to Flow Charts
Pseudo code
Program Development Steps & Algorithms
Computer Operations & Data Types
Comparison Operators
Single Selection
Dual Selection
Three or More Choices
Nested Ifs
Boolean Operators
Loops

Module:2	**Object and Class**	**10 hours**

Types of programming
Disadvantages of functional programming
Class & Objects
Attributes
Methods
Objects
Solving MCQs based on Objects and Classes
Solving tricky questions based on encapsulation
Solving frequently asked object based questions

Module:3	**Data types, Basic I / O**	**10 hours**

Data types
Data
Why data type

Variables
Available data types
Numeric – int, float, double
Character – char, string
Solving MCQs based on type casting, data types
Solving debugging based MCQs

Printing
Getting input from user during run time
Command line arguments
Solving programming questions based on CLA
Solving MCQs questions based on CLA

Module:4	**Decision Making, Loop Control**	**10 hours**

Need for control statement
if..else
if..else if..else
Nested if..else
Switch case
Common mistakes with control statements (like using = instead of ==)
Solving frequently asked questions on decision making

Types of looping statements
Entry Controlled
For
While
Exit Controlled
do while
break and continue
Demo on looping
Common mistakes with looping statements (like using ; at the end of the loop)
Solving pattern programming problems, series problems
Solving predict the output questions

Module:5	**String**	**5 hours**

String handling

	Total Lecture hours:	**45 hours**

Reference Books

1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS3401	Foundation to Programming Skills	L	T	P	J	C
		3	0	0	0	1
Pre-requisite	**None**	**Syllabus version**				
		1.0				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem solving skills in JAVA concepts
- Students will be able to write codes in Java

Module:1	**Object and Class**	**8 hours**

Types of programming
Disadvantages of functional programming
Class & Objects
Attributes
Methods
Objects
Solving MCQs based on Objects and Classes
Solving tricky questions based on encapsulation
Solving frequently asked object based questions

Module:2	**Data types, Basic I / O**	**8 hours**

Data types
Data
Why data type
Variables
Available data types
Numeric – int, float, double
Character – char, string
Solving MCQs based on type casting, data types
Solving debugging based MCQs

Printing
Getting input from user during run time
Command line arguments
Solving programming questions based on CLA
Solving MCQs questions based on CLA

Module:3	**Decision Making, Loop Control**	**9 hours**
Need for control statement if..else if..else if..else Nested if..else Switch case Common mistakes with control statements (like using = instead of ==) Solving frequently asked questions on decision making Types of looping statements Entry Controlled For While Exit Controlled do while break and continue Demo on looping Common mistakes with looping statements (like using ; at the end of the loop) Solving pattern programming problems, series problems Solving predict the output questions		
Module:4	**String, Date, Array**	**10 hours**
String handling, date handling Solving problems based on arrays like searching, sorting, rearranging, iteration) Multi-dimensional arrays Solving pattern problems using 2D arrays Real time application based on 2D arrays		
Module:5	**Inheritance, Aggregation**	**10 hours**
Need Is A – Inheritance Types of inheritance supported Diagrammatic representation Demo on inheritance Has A – Aggregation Diagrammatic representation Demo on aggregation Solving MCQs based on relationships between classes		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies			
Approved by Academic Council	No. 53rd AC	Date	13.12.2018

STS5002	Preparing for Industry	L	T	P	J	C
		3	0	0	0	1
Pre-requisite		**Syllabus version**				
		2.0				

Course Objectives:

1. To develop the students' logical thinking skills
2. To learn the strategies of solving quantitative ability problems
3. To enrich the verbal ability of the students
4. To enhance critical thinking and innovative skills

Expected Course Outcome:

1. Enabling students to simplify, evaluate, analyze and use functions and expressions to simulate real situations to be industry ready.

Module:1	**Interview skills – Types of interview and Techniques to face remote interviews and Mock Interview**	**3 hours**

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview, Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds

Module:2	**Resume skills – Resume Template and Use of power verbs and Types of resume and Customizing resume**	**2 hours**

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

Module:3	**Emotional Intelligence - L1 – Transactional Analysis and Brain storming and Psychometric Analysis and Rebus Puzzles/Problem Solving**	**12 hours**

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways

Module:4	**Quantitative Ability-L3 – Permutation-Combinations and Probability and Geometry**	**14 hours**

	and mensuration and Trigonometry and Logarithms and Functions and Quadratic Equations and Set Theory	
Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram		
Module:5	**Reasoning ability-L3 – Logical reasoning and Data Analysis and Interpretation**	**7 hours**
Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data interpretation-Advanced, Interpretation tables, pie charts & bar chats		
Module:6	**Verbal Ability-L3 – Comprehension and Logic**	**7 hours**
Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Michael Farra and JIST Editors(2011) Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Saint Paul, Minnesota. Jist Works
2.	Daniel Flage Ph.D(2003) The Art of Questioning: An Introduction to Critical Thinking. London. Pearson
3.	David Allen(2002) Getting Things done : The Art of Stress -Free productivity. New York City. Penguin Books.
4.	FACE(2016) Aptipedia Aptitude Encyclopedia.Delhi. Wiley publications
5.	ETHNUS(2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.

Websites:

1.	www.chalkstreet.com
2.	www.skillsyouneed.com
3.	www.mindtools.com
4.	www.thebalance.com

5.	www.eguru.ooo		
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

CHY1002	Environmental Sciences	L	T	P	J	C
		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 individuals contribution in the environmental pollution.
4. To understand the impact of pollution at the global level and also in the local environment.

Expected Course Outcome:

Students will be able to

1. Students will **recognize** the environmental issues in a problem oriented interdisciplinary perspectives
2. Students will **understand** the key environmental issues, the science behind those problems and potential solutions.
3. Students will **demonstrate** the significance of biodiversity and its preservation
4. Students will **identify** various environmental hazards
5. Students will **design** various methods for the conservation of resources
6. Students will **formulate** action plans for sustainable alternatives that incorporate science, humanity, and social aspects
7. Students will have foundational **knowledge** enabling them to make sound life decisions as well as enter a career in an environmental profession or higher education.

Module:1	Environment and Ecosystem	7 hours

Key environmental problems, their basic causes and sustainable solutions. IPAT equation. Ecosystem, earth – life support system and ecosystem components; Food chain, food web, Energy flow in ecosystem; Ecological succession- stages involved, Primary and secondary succession, Hydrarch, mesarch, xerarch; Nutrient, water, carbon, nitrogen, cycles; Effect of human activities on these cycles.

Module:2	**Biodiversity**	**6 hours**
Importance, types, mega-biodiversity; Species interaction - Extinct, endemic, endangered and rare species; Hot-spots; GM crops- Advantages and disadvantages; Terrestrial biodiversity and Aquatic biodiversity – Significance, Threats due to natural and anthropogenic activities and Conservation methods.		
Module:3	**Sustaining Natural Resources and Environmental Quality**	**7 hours**
Environmental hazards – causes and solutions. Biological hazards – AIDS, Malaria, Chemical hazards- BPA, PCB, Phthalates, Mercury, Nuclear hazards- Risk and evaluation of hazards. Water footprint; virtual water, blue revolution. Water quality management and its conservation. Solid and hazardous waste – types and waste management methods.		
Module:4	**Energy Resources**	**6 hours**
Renewable - Non renewable energy resources- Advantages and disadvantages - oil, Natural gas, Coal, Nuclear energy. Energy efficiency and renewable energy. Solar energy, Hydroelectric power, Ocean thermal energy, Wind and geothermal energy. Energy from biomass, solar-Hydrogen revolution.		
Module:5	**Environmental Impact Assessment**	**6 hours**
Introduction to environmental impact analysis. EIA guidelines, Notification of Government of India (Environmental Protection Act – Air, water, forest and wild life). Impact assessment methodologies. Public awareness. Environmental priorities in India.		
Module:6	**Human Population Change and Environment**	**6 hours**
Urban environmental problems; Consumerism and waste products; Promotion of economic development – Impact of population age structure – Women and child welfare, Women empowerment. Sustaining human societies: Economics, environment, policies and education.		
Module:7	**Global Climatic Change and Mitigation**	**5 hours**
Climate disruption, Green house effect, Ozone layer depletion and Acid rain. Kyoto protocol, Carbon credits, Carbon sequestration methods and Montreal Protocol. Role of Information technology in environment-Case Studies.		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**
Text Books		

1.	G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengage learning.
2.	George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.

Reference Books

1.	David M.Hassenzahl, Mary Catherine Hager, Linda R.Berg (2011), Visualizing Environmental Science, 4thEdition, John Wiley & Sons, USA.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT

Recommended by Board of Studies	12.08.2017		
Approved by Academic Council	No. 46	Date	24.08.2017