RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
R.V. Vidyaniketan Post, Mysore Road
Bengaluru – 560 059

Bachelor of Engineering (B.E.)
Scheme and Syllabus of V &VI Semesters

2018 SCHEME

COMPUTER SCIENCE AND ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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Bachelor of Engineering (B.E.)
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2018 SCHEME

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DEPARTMENT VISION

To achieve leadership in the field of Computer Science & Engineering by strengthening fundamentals and facilitating interdisciplinary sustainable research to meet the ever growing needs of the society.

DEPARTMENT MISSION

- To evolve continually as a centre of excellence in quality education in computers and allied fields.
- To develop state-of-the-art infrastructure and create environment capable for interdisciplinary research and skill enhancement.
- To collaborate with industries and institutions at national and international levels to enhance research in emerging areas.
- To develop professionals having social concern to become leaders in top-notch industries and/or become entrepreneurs with good ethics.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Develop Graduates capable of applying the principles of mathematics, science, core engineering and Computer Science to solve real-world problems in interdisciplinary domains.

PEO2: To develop the ability among graduates to analyze and understand current pedagogical techniques, industry accepted computing practices and state-of-art technology.

PEO3: To develop graduates who will exhibit cultural awareness, teamwork with professional ethics, effective communication skills and appropriately apply knowledge of societal impacts of computing technology.

PEO4: To prepare graduates with a capability to successfully get employed in the right role / become entrepreneurs to achieve higher career goals or takeup higher education in pursuit of lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	**System Analysis and Design** The student will be able to: 1. Recognize and appreciate the need of change in computer architecture, data organization and analytical methods in the evolving technology. 2. Learn the applicability of various systems software elements for solving design problems. 3. Identify the various analysis & design methodologies for facilitating development of high quality system software products with focus on performance optimization. 4. Display team participation, good communication, project management and document skills.
PSO2	**Product Development** The student will be able to: 1. Demonstrate the use of knowledge and ability to write programs and integrate them with the hardware/software products in the domains of embedded systems, databases /data analytics, network/web systems and mobile products. 2. Participate in planning and implement solutions to cater to business – specific requirements displaying team dynamics and professional ethics. 3. Employ state-of-art methodologies for product development and testing / validation with focus on optimization and quality related aspects.

Lead Society: Institute of Electrical and Electronics Engineers (IEEE)

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	PE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics

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COMPUTER SCIENCE AND ENGINEERING

FIFTH SEMESTER CREDIT SCHEME							
Sl. No	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	**T**	**P**	
1.	18HSI51	Intellectual Property Rights and Entrepreneurship	HSS	3	0	0	**3**
2.	18CS52	Finite Automata Formal Languages	CS	3	0	0	**3**
3.	18CS53	Database Design (Common to CS & IS)	CS	3	0	1	**4**
4.	18CS54	Network Programming and Security	CS	3	0	1	**4**
5.	18IS55	Software Engineering (Common to CS & IS)	IS	3	0	1	**4**
6.	18CS5AX	Group A: Professional Electives (MOOC Courses)	CS	3	0	0	**3**
7.	18G5BXX	Group B: Global Elective	Resp. BoS	3	0	0	**3**
Total Number of Credits				21	0	3	**24**
Total number of Hours/Week				**21**	**0**	**7.5**	

GROUP A: PROFESSIONAL ELECTIVES (MOOC COURSES)			
Sl. No.	**Course Code**	**Course Title**	**Duration**
1.	18CS5A1	Object Oriented System Development using UML, Java and Patterns (Common to CS & IS)	12 Weeks
2.	18IS5A2	Social Networks (Common to CS & IS)	12 Weeks
3.	18CS5A3	Applied Natural Language Processing	12 Weeks
4.	18CS5A4	Introduction to robotics	12 Weeks
5.	18CS5A5	The Joy of Computing using Python (Common to All Branches)	12 Weeks

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COMPUTER SCIENCE AND ENGINEERING

SIXTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	**T**	**P**	
1.	18HEM61	Introduction to Management & Economics	HSS	3	0	0	**3**
2.	18CS62	Artificial Intelligence and Machine Learning (Common to CS & IS)	CS	3	1	1	**5**
3.	18CS63	Compiler Design	CS	3	0	1	**4**
4.	18CS64	Minor Project	CS	0	0	2	**2**
5.	18CS6CX	Group C: Professional Electives	CS	3	0	0	**3**
6.	18CS6DX	Group D: Professional Electives	CS	3	0	0	**3**
7.	18G6EXX	Group E: Global Elective	Resp. BoS	3	0	0	**3**
8.	18HS68	Professional Practice-II (Employability Skills and Professional Development of Engineers)	HSS	0	0	1	**1**
Total Number of Credits							**24**
Total number of Hours/Week				**18**	**2**	**10+2.5**	

GROUP C: PROFESSIONAL ELECTIVES			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	18CS6C1	Internet of Things (common to all branches)	03
2.	18IS6C2	Advanced Algorithms (Common to CS & IS)	03
3.	18CS6C3	Fuzzy Logic (Common to CS & IS)	03
4.	18CS6C4	Data Warehousing and Data mining	03
5.	18CS6C5	Big Data Analytics Using Distributed Platforms(**Industry Offered)** (Common to CS & IS)	03

GROUP D: PROFESSIONAL ELECTIVES			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	18IS6D1	Web Technology (Common to CS & IS)	03
2.	18CS6D2	Quantum Computing	03
3.	18CS6D3	Artificial Neural networks	03
4.	18CS6D4	Probability, Statistics and Queuing Theory	03
5.	18CS6D5	Robotic Process Automation Design & Development (**Industry Offered)**	03

GROUP B: GLOBAL ELECTIVES				
Sl. No.	**Dept**	**Course Code**	**Course Title**	**Credits**
Courses offered by the Departments				
1.	AS	18G5B01	Fundamentals of Aerospace Engineering	03
2.	BT	18G5B02	Nanotechnology	03
3.	CH	18G5B03	Fuel Cell Technology	03
4.	CS	18G5B04	Intelligent Systems	03
5.	CV	18G5B05	Remote Sensing and Geographic Information System	03
6.	EC	18G5B06	Automotive Electronics	03
7.	EE	18G5B07	E-Mobility	03
8.	EI	18G5B08	Smart Sensors & Instrumentation	03
9.	IM	18G5B09	Operations Research	03
10.	IS	18G5B10	Management Information Systems	03
11.	ME	18G5B11	Automotive Mechatronics	03
12.	TE	18G5B12	Telecommunication Systems	03
Courses offered by Science Departments & HSS Board				
13.	PY	18G5B13	Quantum Mechanics of Hetero/Nano Structures	03
14.	PY	18G5B14	Thin Films and Nanotechnology	03
15.	CY	18G5B15	Advances in Corrosion Science and Technology	03
16.	MA	18G5B16	Computational Advanced Numerical Methods	03
17.	MA	18G5B17	Mathematics for Machine Learning	03
18.	HSS	18G5B18	Engineering Economy	03

GROUP E: GLOBAL ELECTIVES				
Sl. No.	**Dept**	**Course Code**	**Course Title**	**Credits**
Courses offered by the Departments				
1.	AS	18G6E01	Aircraft Systems	03
2.	BT	18G6E02	Bioinspired Engineering	03
3.	CH	18G6E03	Sustainable Technology	03
4.	CS	18G6E04	Graph Theory	03
5.	CV	18G6E05	Disaster Management	03
6.	EC	18G6E06	Wearable Electronics	03
7.	EE	18G6E07	Energy Auditing and Management	03
8.	EI	18G6E08	Virtual Instrumentation & Applications	03
9.	IM	18G6E09	Systems Engineering	03
10.	IS	18G6E10	Introduction to Mobile Application Development	03
11.	ME	18G6E11	Industrial Automation	03
12.	TE	18G6E12	Mobile Network System and Standards	03
Courses offered by Science Departments& HSS Board				
13.	PY	18G6E13	Thin Film Nanodevice Fabrication Technology	03
14.	CY	18G6E14	Chemistry of Advanced Energy Storage Devices for E-Mobility	03
15.	MA	18G6E15	Advanced Statistical Methods	03
16.	MA	18G6E16	Mathematical Modeling	03
17.	HSS	18G6E17	Foundational Course on Entrepreneurship	03

V Semester						
INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP (Theory)						
Course Code	**:**	**18HSI51**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**03Hrs**

Course Learning Objectives: The students will be able to

1	To build awareness on the various forms of IPR and to build the perspectives on the concepts and to develop the linkages in technology innovation and IPR.
2	To encourage innovation, invention and investment and disclosure of new Technology and to recognize and reward innovativeness
3	To motivate towards entrepreneurial careers and build strong foundations skills to enable starting, building and growing a viable as well as sustainable venture.
4	Develop an entrepreneurial outlook and mind set along with critical skills and knowledge to manage risks associated with entrepreneurs.

Unit-I	**08 Hrs**
Introduction: Types of Intellectual Property, WIPO **Patents:** Introduction, Scope and salient features of patent; patentable and non-patentable inventions, Patent Procedure - Overview, Transfer of Patent Rights; Biotechnology patents, protection of traditional knowledge, Infringement of patents and remedy, Case studies **Trade Secrets:** Definition, Significance, Tools to protect Trade secrets in India.	
Unit – II	**08 Hrs**
Trade Marks: Concept, function and different kinds and forms of Trade marks, Registrable and non-registrable marks. Registration of Trade Mark; Deceptive similarity; Transfer of Trade Mark, ECO Label, Passing off, Infringement of Trade Mark with Case studies and Remedies.	
Unit –III	**09 Hrs**
Industrial Design: Introduction of Industrial Designs Features of Industrial, Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies **Copy Right:** Introduction, Nature and scope, Rights conferred by copy right, Copy right protection, transfer of copy rights, right of broad casting organizations and performer's rights, Exceptions of Copy Right, Infringement of Copy Right with case studies **Intellectual property and cyberspace:** Emergence of cyber-crime; Meaning and different types of cybercrime. Overview of Information Technology Act 2000 and IT Amendment Act 2008	
Unit –IV	**07 Hrs**
Introduction to Entrepreneurship – Learn how entrepreneurship has changed the world. Identify six entrepreneurial myths and uncover the true facts. Explore E-cells on Campus **Listen to Some Success Stories: -** Global legends Understand how ordinary people become successful global entrepreneurs, their journeys, their challenges, and their success stories. Understand how ordinary people from their own countries have become successful entrepreneurs. **Characteristics of a Successful Entrepreneur** Understand the entrepreneurial journey and learn the concept of different entrepreneurial styles. Identify your own entrepreneurship style based on your personality traits, strengths, and weaknesses. Learn about the 5M Model, each of the five entrepreneurial styles in the model, and how they differ from each other. **Communicate Effectively:** Learn how incorrect assumptions and limiting our opinions about people can negatively impact our communication. Identify the barriers which cause communication breakdown, such as miscommunication and poor listening, and learn how to overcome them. **Communication Best Practices.** Understand the importance of listening in communication and learn to listen actively. Learn a few body language cues such as eye contact and handshakes to strengthen communication. (Practical Application)	
Unit –V	**07Hrs**
Design Thinking for Customer Delight: - Understand Design Thinking as a problem-solving process. Describe the principles of Design Thinking. Describe the Design Thinking process.	

Sales Skills to Become an Effective Entrepreneur: - Understand what customer focus is and how all selling effort should be customer-centric. Use the skills/techniques of personal selling, Show and Tell, and Elevator Pitch to sell effectively. **Managing Risks and Learning from Failures: -** Identify risk-taking and resilience traits. Understand that risk-taking is a positive trait. Learn to cultivate risk-taking traits. (Practical Application) Appreciate the role of failure on the road to success, and understand when to give up. Learn about some entrepreneurs/risk-takers. (Practical Application). **Are You Ready to be an Entrepreneur: -** Let's ask "WHY" Give participants a real picture of the benefits and challenges of being an entrepreneur. Identify the reasons why people want to become entrepreneurs. Help participants identify why they would want to become entrepreneurs.

Reference Books	
1.	Law Relating to Intellectual Property, Wadehra B L,5th Edition, 2012, Universal Law Pub Co. Ltd.-Delhi, ISBN: 9789350350300
2.	Intellectual Property Rights: Unleashing Knowledge Economy, PrabuddhaGanguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602.
3.	Intellectual Property and the Internet, Rodney Ryder, 2002, Lexis Nexis U.K., ISBN: 8180380025, 9788180380020.
4.	Entrepreneurship, Rajeev Roy, 1st Edition, 2012, Oxford University Press, New Delhi, ISBN: 9780198072638.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Comprehend the applicable source, scope and limitations of Intellectual Property within the purview of engineering domain.
CO2:	Knowledge and competence related exposure to the various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives.
CO3:	Enable the students to have a direct experience of venture creation through a facilitated learning environment.
CO4:	It allows students to learn and apply the latest methodology, frameworks and tools that entrepreneurs use to succeed in real life.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20. **50% weightage should be given to case studies. Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.**50% weightage should be given to case studies.**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**2**	**2**	**-**	**1**
CO2	**1**	**1**	**-**	**-**	**-**	**3**	**2**	**3**	**1**	**2**	**-**	**1**
CO3	**-**	**1**	**-**	**-**	**-**	**2**	**1**	**3**	**3**	**3**	**3**	**3**
CO4	**-**	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**1**	**-**	**2**	**1**

High-3 : Medium-2 : Low-1

Semester: V						
FINITE AUTOMATA FORMAL LANGUAGES (Theory)						
Course Code	**:**	**18CS52**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to

1.	Understand fundamental concepts of theory of computation and the use of mathematical thinking as it is applied to Computer Science.
2.	Compare finite automata; push down automata and Turing machines as Mathematical models of computation.
3.	Develop the concepts and skills necessary to be able to evaluate the computability and complexity of practical computational problems.
4.	Understand formal thought processes, computation, algorithms and their limits.
5.	Design a machine model to accept a specified language

Unit – I	**8 Hrs**
Regular Languages and Regular Expressions, Memory Required to Recognize a Language, Deterministic Finite Automata (DFA), Non Deterministic Finite Automata (NFA), Non Deterministic Finite Automata with ϵ -transitions (NFA-ϵ), Equivalence, Regular Expressions and Finite Automata, Applications of Regular Expressions, Algebraic laws of Regular Expressions, Minimization of Finite Automata.	
Unit – II	**8 Hrs**
Pumping Lemma for Regular Languages, Closure properties of Regular Languages, Decision properties of Regular languages, Context-free grammars (CFG), Parse trees, Applications, Ambiguity in grammars & languages, Simplification of CFG, Normal forms of CFGs. Regular Grammars, Equivalence of Regular Grammars and Finite Automata.	
Unit – III	**8 Hrs**
Push Down Automata (PDA): Definition, the languages of a PDA, Equivalence of PDA's & CFG's, Deterministic PDA. The Pumping Lemma for Context Free Languages (CFL), Closure properties of CFLs, Decision properties of CFLs	
Unit – IV	**8 Hrs**
Turing Machines (TM): Definitions and Examples, TM as a Language Accepter, Computing Partial Functions with Turing Machine, Variations of Turing Machines, Combining Turing Machines, Non Deterministic TM, Universal TM, Recursively Enumerable Languages (REL) and Recursive Languages. Properties of REL and Recursive Languages.	
Unit – V	**7 Hrs**
More General Grammars, Unrestricted Grammar, Context Sensitive Languages (CSL) and Linear Bounded Automata (LBA), Chomsky Hierarchy, Not all languages are Recursively Enumerable, Unsolvable Problem, Reducing One problem to another, The halting problem of TM, Post's Correspondence Problem (PCP), Time and Space Complexity of TM.	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand the fundamental concepts of theory of computations.
CO 2:	Analyze the tools of finite automata to various fields of computer science.
CO 3:	Design solution model for complex problems, using the appropriate skills of automata theory for better results.
CO 4:	Apply automata skills in situations that describe computation effectively and efficiently.

Reference Books:	
1.	Introduction to Languages & Theory of Computation, John C Martin, 4th Edition, 2011, Tata McGraw-Hill, ISBN: 978-0-07-319146-1.
2.	Introduction to Automata Theory, Languages & Computation, J.P.Hopcroft, Rajeev Motwani, J.D.Ullman, 3rd Edition, 2008,Pearson Education., ISBN:81-3172-047-0.
3.	An Introduction To Formal Languages & Automata, Peter Linz, 6th Edition, 2007, Narosa Publishing House, ISBN: 07-6371-422-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**1**	**2**	**1**	**2**	**-**	**3**	**-**	**2**	**2**	**2**	**1**
CO2	**-**	**3**	**-**	**-**	**1**	**2**	**3**	**-**	**3**	**2**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**2**	**-**	**2**	**-**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**2**	**1**	**1**	**2**	**-**	**3**	**2**	**2**	**3**	**1**

High-3: Medium-2: Low-1

Semester: V						
DATABASE DESIGN (Theory & Practice) (Common to CS and IS)						
Course Code	**:**	**18CS53**		**CIE Marks**	**:**	**100+50**
Credits: L:T:P	**:**	**3 :0:1**		**SEE Marks**	**:**	**100+50**
Total Hours	**:**	**39L + 35P**		**SEE Duration**	**:**	**3 Hrs + 3 Hrs**
Course Learning Objectives: The students will be able to						
1.	Explore the evolution of the database systems from traditional file systems.					
2.	Describe the major components of relational and NoSQL database system.					
3.	Describe the functionality provided by languages such as SQL and NoSQL.					
4.	Investigate the usage of transaction, concurrency control and recovery techniques.					

Unit – I	**7Hrs**
Introduction to Database Systems -Databases and Database users: Introduction, An example, Characteristics of Database Approach, Actors on the scene, Workers behind the scene. Database System—Concepts and Architecture: Data Models, Schemas and Instances, Three-schema Architecture and Data Independence, Database Languages and Interfaces, The Database System Environment. **Data Modeling Using the Entity-Relationship Model-**Using High-Level Conceptual Data Models for Database Design; A Sample Database Application; Entity Types, Entity Sets, Attributes and Keys; Relationship types, Relationship Sets, Roles and Structural Constraints; Weak Entity Types;	
Unit – II	**8Hrs**
Refining the ER Design for the COMPANY Database; ER Diagrams, Naming onventions and Design Issues, Using ER- to-Relational Mapping. **Relational Model and Relational Algebra-**Relational Model Concepts; Relational Model Constraints and Relational Database Schemas; Update Operations and Dealing with Constraint Violations; Unary Relational Operations: SELECT and PROJECT; Relational Algebra Operations from Set Theory; Binary Relational Operations: JOIN and DIVISION ;Additional Relational Operations; Examples of Queries in Relational Algebra; Relational Database Design**.**	
Unit – III	**8Hrs**
SQL Schema Definition, Basic Constraints and Queries-SQL Data Definition, Specifying Constraints in SQL, Schema Change Statements in SQL; Basic Queries in SQL; Insert, Delete and Update Statements in SQL More Complex SQL Retrieval Queries. **Relational Database Design -** Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form; Properties of Relational Decompositions; Multivalued Dependencies, Fourth Normal Form and Fifth Normal Form.	
Unit – IV	**8Hrs**
Transaction Processing Concepts- Introduction to transaction processing, Transaction states and additional operations, Desirable properties of transaction, Schedules of transactions, Characterizing schedules based on Recoverability, Characterizing schedules based on Serializability: Serial, Nonserial and Conflict-Serializable schedules, Testing for Conflict serializability of schedule, Uses of serializability. **Concurrency Control Techniques:** Two phase locking techniques for concurrency control, types of locks and system lock tables, Guaranteeing serializability by two-phase locking, Dealing with Deadlock and starvation, Concurrency control based on timestamp ordering.	
Unit – V	**8 Hrs**
Database Recovery Techniques: Recovery Concepts, Shadow Paging, The ARIES recovery. **Introduction to NoSQL**- Aggregate data models : aggregates, key-value and document data models.	

Relationships: graph : databases , schemaless databases Distribution models :sharding, master-slave replication, peer-peer replication –combining sharding and replication.
Laboratory Component Open Ended Mini Project should be implemented and shall be carried out in a batch of two students. The students will finalize a topic in consultation with the faculty. The Mini Project tasks would involve: • Understand the complete domain knowledge of application and derive the complete data requirement specification. • Design of the project with Integrated database solution (SQL, NOSQL and emerging techniques) • Normalization of the Relational design up to 3NF (Desirable 5NF). • Appreciate the importance of security for database systems. • Documentation and submission of report.

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand and explore the needs and concepts of relational and NoSQL database.
CO 2:	Apply the knowledge of logical database design principles to real time issues.
CO 3:	Analyze and design relational and NoSQL data model concepts
CO 4:	Develop applications using relational and NoSQL database

Reference Books:	
1.	Fundamentals of Database Systems, Elmasri and Navathe, 7th Edition, 2016,Pearson Education, ISBN-13: 978-0-13-397077-7.
2.	NoSQL A brief guide to the emerging world of Polyglot Persistence, Pramod J Sdalage, Martin Fowler, 2012, Addison-Wesley, ISBN 978-0-321-82662-6,
3.	Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition, 2003, McGraw-Hill, ISBN : 978-0072465631.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub

questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**2**
CO2	**-**	**1**	**1**	**1**	**1**	**-**	**1**	**-**	**1**	**2**	**-**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**-**	**1**	**1**	**2**	**2**	**1**	**2**
CO4	**2**	**2**	**3**	**2**	**3**	**-**	**-**	**2**	**3**	**3**	**2**	**1**

High-3: Medium-2: Low-1

Semester: V						
NETWORK PROGRAMMING AND SECURITY (Theory & Practice)						
Course Code	**:**	**18CS54**		**CIE Marks**	**:**	**100+50**
Credits: L:T:P	**:**	**3 :0:1**		**SEE Marks**	**:**	**100+50**
Total Hours	**:**	**39L + 35P**		**SEE Duration**	**:**	**3 Hrs + 3 Hrs**

Course Learning Objectives: The students will be able to

1.	Understand and Explore the OSI reference model and a variety of network concepts and protocols.
2.	Analyzethe interoperability of networking protocols and its usage.
3.	Explore and implement the client/server communication on Unix platforms.
4.	Applyand analyze the cryptographic algorithms to ensure secure transfer of secret keys and encryption/decryption of messages.

Unit – I	**8 Hrs**
The Transport Layer and introduction to sockets Introduction to TCP, UDP and SCTP, The big picture, Difference between UDP, TCP, SCTP, TCP connection establishment and termination, TIME_WAIT state, TCP port numbers and concurrent servers, Buffer sizes and limitation.Socket address structure, value result arguments, byte ordering functions, byte manipulation functions, inet_aton, inet_addr and inet_ntoa functions, inet_pton and inet_ntop functions.	
Unit – II	**8Hrs**
TCP client/server Socket function, connect function, bind, listen, accept, fork, exec functions, concurrent servers, close function, getsockname and getpeername functions, TCP Echo server – main – str_echo ,TCP Echo client - main – str_echo, Normal startup, normal termination.	
Unit – III	**8Hrs**
UDP client/server and Name server Socket options introduction, getsockopt and setsockopt functions. recvfrom and sendto functions, UDP Echo server & UDP Echo client, lost datagrams. DNS, Gethostbyname function, gethostbyaddr function, getservbyname and getservbyport functions, getaddrinfo function, gai_strerror function, freeaddrinfo function, getaddrinfo function: example, host_serv function.	
Unit – IV	**8Hrs**
Traditional Block Cipher and Public Key Cryptosystem Stream Ciphers and Block Ciphers, Feistel Cipher Structure. The Data Encryption Standard-Encryption and Decryption. Principles of Public Cryptosystems- Public-Key Cryptosystems, Applications for Public-Key Cryptosystems Requirements for Public-Key Cryptosystems, Public-Key Cryptanalysis. The RSA algorithm-Description of the Algorithm, Computational Aspects. The security of RSA, Other Public key Cryptosystems: Diffie-Hellman Key Exchange: The Algorithm, Key Exchange Protocols, Man-in-the Middle Attack.	
Unit – V	**7Hrs**
Transport Layer Security and Wireless Network Security Web Security Considerations, Secure Socket Layer, Transport Layer security, HTTPS. Wireless NetworkSecurity: Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN overview, IEEE 802.11i Wireless LAN Security – Services, Phases of operation.	

Laboratory Component

List of Experiments

PART - A: EXPERIMENTS

1. Implement a client and server communication using sockets programming.
2. Write a program to implement distance vector routing protocol for a simple topology of routers.

3. Write a program to implement error detection and Correction concept using Checksum and Hamming code.
4. Implement a simple multicast routing mechanism.
5. Write a program to implement concurrent chat server that allows current logged in users to communicate one with other.
6. Implementation of concurrent and iterative echo server using both connection and connectionless socket system calls.
7. Implementation of remote command execution using socket system calls.
8. Write a program to encrypt and decrypt the data using RSA and Exchange the key securely using Diffie-Hellman Key exchange protocol.

Note: The above experiments shall be conducted using C / C++ on Linux Operating System.

PART – B: SIMULATION

1. Setup an IEEE 802.3 network with a) hub b) switch c) Hierarchy of switch. Apply theFTP, Telnet applications between nodes. Vary the number of nodes. Vary the bandwidth,queue size and observe the packet drop probability.

2. Setup a wireless sensor networks with atleast two device co-coordinators and nodes.Provide Constant Bit Rate (CBR), Variable Bit Rate (VBR) application between severalnodes. Increase the number of co-coordinators and nodes in the same area and observe theperformance at physical and MAC layers.

3. Setup an IEEE 802.11 network with atleast two access points. Apply the CBR, VBRapplications between devices belonging to same access points and different access points.Provide roaming of any device. Vary the number of access points and devices. Find outthe delay in MAC layer, packet drop probability.

4. Case Study on Configuring Routers using CISCO-Packet tracer.

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand and Explore the OSI reference model and a variety of network concepts and protocols.
CO 2:	Analyze network Protocols interoperability and application.
CO 3:	Design and demonstrate client/server programs on Unix platforms to create robust real-world sockets-based applications.
CO 4:	Apply appropriate cryptographic algorithms to ensure security of information through wired and wireless medium.

Reference Books:	
1.	UNIX Network Programming – The sockets networking API, W.Richard Stevens, Bill Fenner, Andrew M. Rudoff, Vol.I , 3rdedition, PHI. ISBN-13: 978-0131411555 ISBN-10: 9780131411555.
2.	Cryptography and Network Security Principles and Practice, William Stallings, 7th edition, 2017, Global edition, Pearson Education,ISBN: 978-0-13-444428-4.
3.	Internetworking with TCP/IP, Douglas E. Comer, David L. Stevens, Vol. III, 6th Edition, 2015, Paperback, Publisher: Pearson India, ISBN-10: 9332549877, ISBN-13: 978-9332549876.
4.	Learning Network Programming with Java, Richard M Reese, First Published: December 2015, Packet Publishing Ltd.,ISBN-13: 978-0123742551, ISBN-10: 0123742552.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**1**
CO2	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**1**
CO3	**3**	**3**	**3**	**3**	**2**	**-**	**1**	**1**	**1**	**1**	**1**	**2**
CO4	**2**	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**3**

High-3: Medium-2: Low-1

Semester: V						
SOFTWARE ENGINEERING (Theory & Practice) (Common to CS & IS)						
Course Code	**:**	**18IS55**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**39L+35P**		**SEE Duration**	**:**	**3.00+3:00 Hrs**

Course Learning Objectives: The students will be able to

1	Understand the activities involved in Software Engineering Process
2	Compare various models for software design, development and testing
3	Comprehend concepts of UML and component based software engineering
4	Apply Software planning techniques for efficient Software management

Unit-I	**08 Hrs**
Overview: Introduction: Professional Software Development, Software Engineering Ethics, Case studies. . **Software Processes**: Models, Process activities, Coping with Change, Process improvement. The Rational Unified Process. Computer Aided Software Engineering. Agile Software Development: Introduction to agile methods, Agile development techniques, Agile project management and scaling agile methods.	
Unit – II	**08 Hrs**
Requirements Engineering and System Modeling: Software Requirements: Functional and Non-functional requirements. Requirements Elicitation, Specification, Validation and Change. System Modeling: Context models, Interaction models, Structural models, Behavioural models, Model driven architecture. Architectural Design: Design decisions, Architectural views, Architectural patterns and architectures.	
Unit –III	**08 Hrs**
Development and Testing: Design and implementation: Object oriented design using UML, Design patterns, Implementation issues, Open-source development. Software Testing: Development testing, Test-driven development, Release testing, User testing. **Software Evolution**: Evolution processes. Legacy system evolution, Software maintenance	
Unit –IV	**08 Hrs**
Advanced Software Engineering: Dependable systems**:** Dependability properties, Sociotechnical systems, dependable processes, formal methods and dependability, Reliability engineering: Availability and reliability, reliability requirements, Reliability measurements, Component based software engineering: Components and component models, CBSE processes, component composition.	
Unit –V	**07 Hrs**
Software Management: Project Management: Risk Management, Managing People, Teamwork, Project Planning: Software Pricing, Plan driven development, Project Scheduling, Agile planning, Estimation Techniques, COCOMO cost modeling.	

Laboratory Component

PART-A

Software Engineering Virtual Labs will be used to carry out activities weekly in the laboratory. The Virtual Lab is a MHRD, Govt. of India initiative.
http://vlabs.iitkgp.ac.in/se/
List of Experiments:

1) Identifying the Requirements from Problem Statements
2) Estimation of Project Metrics
3) Modeling UML Use Case Diagrams and Capturing Use Case Scenarios
4) Identifying Domain Classes from the Problem Statements
5) State chart and Activity Modeling
6) Modeling UML Class Diagrams and Sequence diagrams
7) Modeling Data Flow Diagrams
8) Estimation of Test Coverage Metrics and Structural Complexity
9) Designing Test Suites

PART-B

Student will analyse, design, and implement an application using the appropriate Software engineering tools and practices. All topics learnt in virtual lab (SE phases) need to be covered. A report of the same is expected to be submitted.
Some example applications are listed below(not limited to):

- Automated banking application
- Online shopping portal
- CIE seating arrangement
- SEE Exam invigilation duty allotment
- UG Project Evaluation system
- Employee Payroll system

List of Submissions:

1) Requirements Analysis document
2) Design document
3) Implementation details
4) Testing document with appropriate test cases.

Constraints and Dependencies

Course Outcomes: After completing the course, the students will be able to	
CO1:	Comprehend various software life cycle models and steps of software development process.
CO2:	Apply concepts of Software Project Planning and software Design techniques
CO3:	Analyze capabilities of various tools to assist in the software development activities
CO4:	Develop robust software design and software project plan from requirement gathering to implementation

Reference Books	
1	Ian Sommerville," Software Engineering", 9th Edition, Pearson Education, 2013, ISBN: 9788131762165
2	Roger.S.Pressman," Software Engineering-A Practitioners Approach", 7th Edition, Tata McGraw Hill, 2007, ISBN: 9780071267823
3	Pankaj Jalote," An Integrated Approach to Software Engineering", 3rd Edition, Narosa Publishing House, 2013, ISBN: 9788173197024
4	Rajib Mall, Fundamentals of Software Engineering, 3rd Edition, Prentice-hall Of India Pvt Ltd., 2012, ISBN: 9788120348981.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
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CO1	**1**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**1**	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**

High-3: Medium-2: Low-1

Semester: V						
OBJECT ORIENTED SYSTEM DEVELOPMENT USING UML, JAVA AND PATTERNS **(Group A: PROFESSIONAL ELECTIVES, MOOC COURSE)** **(Common to CS & IS)**						
Course Code	**:**	**18CS5A1**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to	
1.	Specify, Design, Build and Understand Complex software systems
2.	Acquire knowledge of notations and process of object-oriented analysis and design
3.	Explore the object-oriented approach to system development, modeling objects, relationships and interactions.
4.	Demonstrate design concepts through Unified Modelling Language (UML)
5.	Visualize, Specify, Construct and Document the artifacts of software-intensive system

Unit – I	**8 Hrs**
Introduction, Life Cycle Models for Object Oriented Development, modellingUse Case Diagrams using appropriate Unified Modeling Language (UML) notations.	
Unit – II	**8 Hrs**
Class Diagram I, Class Diagram II, Designing software systems by modelling classes, objects, relationships and their interactions using appropriate Unified Modeling Language (UML) notations.	
Unit – III	**8 Hrs**
Designing Sequence Diagrams, State chart diagrams using appropriate Unified Modeling Language (UML) notations	
Unit – IV	**8 Hrs**
Design process, Introduction to design patterns, GRASP (General Responsibility Assignment Software Patterns) patterns	
Unit – V	**7 Hrs**
GoF (Gang of Four) Design pattern I, GoF (Gang of Four) Design Pattern II	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Explore and discuss Object Oriented analysis and Design Principles to evaluate requirement analysis, System Behavior and Object Model
CO 2:	Apply the knowledge of object oriented concepts for modeling software systems design problems.
CO 3:	Analyze the requirements of the problem and design solutions to complex problems using UML notations.
CO 4:	Design object oriented models for software systems using appropriate UML notations and Design Patterns.

Reference Books:	
1.	UML for Java Programmers, Robert Martin, 1st edition, 2004, Pearson Education; ISBN 978-8177586756
2.	Object Oriented Systems Development using the Unified ModellingLanguage, Ali Bahrami, 2ndReprint 2008,McGraw Hill, ISBN:978-0-07-026512-7
3.	The Unified Modeling Language UserGuide, Grady Booch, James Rumbaugh, Ivar Jacobson , 2nd Edition, 2005,Addison Wesley Professional, ISBN: 0-321-26797-4

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	-	-	**1**
CO2	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**-**	**-**	**1**	1	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	2	2	**-**	**1**	**-**	**-**	**1**	1	1	**-**	**2**

High-3: Medium-2: Low-1

Semester: V						
SOCIAL NETWORKS **(Group A: PROFESSIONAL ELECTIVES, MOOC COURSE)** **(Common to CS & IS)**						
Course Code	**:**	**18IS5A2**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to	
1.	Understand the basic concepts of Social Networks
2.	Illustrate various methods for Network analysis
3.	Understand and distinguish how Social Network help society and its impact.
4.	Create and use appropriate technology to implement useful applications of Social Networks
5.	Understand how social networks can be used without breaching privacy, security of individuals and institutions

Unit – I	**8 Hrs**
Introduction, Handling Real-world Network Datasets	
Unit – II	**8 Hrs**
Strength of Weak Ties, Strong and Weak Relationships (Continued) &Homophily	
Unit – III	**8 Hrs**
Homophily Continued and +Ve / -Ve Relationships, Link Analysis, Cascading Behaviour in Networks	
Unit – IV	**8 Hrs**
Link Analysis (Continued), Power Laws and Rich-Get-Richer Phenomena, Power law (contd..) and Epidemics	
Unit – V	**7 Hrs**
Small World Phenomenon, Pseudocore (How to go viral on web)	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand the concepts and features of Social networks
CO 2:	Analyze various methods of social network analysis
CO 3:	Design applications using social network analysis
CO 4:	Implement programs that are useful to society without breaching security, privacy of individuals and others

Reference Books:	
1.	Networks, Crowds and Markets, David Easley and Jon Kleinberg, 2010, Cambridge University Press. ISBN: 9780521195331, 9780521195331
2.	Social and Economic Networks, Matthew O. Jackson, 2010, Princeton University Press. ISBN-13: 978-0691148205, ISBN-10: 0691148201

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**										
CO2	**2**	**2**										
CO3	**2**	**2**	**2**	**2**			**1**	**2**	**2**	**1**	**1**	**1**
CO4	**2**	**2**	**2**	**2**	**1**	**2**	**1**	**3**	**2**	**1**	**1**	**1**

High-3: Medium-2: Low-1

Semester: V						
APPLIED NATURAL LANGUAGE PROCESSING (Group A: PROFESSIONAL ELECTIVES, MOOC COURSE)						
Course Code	**:**	**18CS5A3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to

1.	Introduce various techniques to find similar words using the context of surrounding words
2.	Build a Language model to predict the next word and generate sentences
3.	Encode every word in the vocabulary of the corpus into a vector form that represents its context and similar words
4.	Encode a sentence for machine translation and conversation purposes.
5.	To gather sufficient knowledge and proficiency in probabilistic, Artificial Neural Network (ANN) and deep learning techniques for NLP.

Unit – I	**8 Hrs**
Introduction, terminologies, empirical rules Word to Vectors Probability and Language Model	
Unit – II	**8 Hrs**
Neural Networks for NLP Distributed word vectors (word embeddings) Recurrent Neural Network, Language Model	
Unit – III	**8 Hrs**
Statistical Machine Translation Statistical Machine Translation, Neural Machine Translation Neural Machine Translation	
Unit – IV	**8 Hrs**
Conversation Modeling, Chat-bots, dialog agents, Question Processing Information Retrieval tasks using Neural Networks- Learn to Rank, Understanding Phrases, analogies Spelling Correction using traditional and Neural networks, end notes	
Unit – V	**7 Hrs**
Practical Applications of NLP	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand approaches to syntax and semantics in NLP.
CO 2:	Understand Apply approaches to discourse, generation, dialogue and summarization within NLP.
CO 3:	Analyze current methods for statistical approaches to machine translation.
CO 4:	Understand machine learning techniques used in NLP, including hidden Markov models and probabilistic context-free grammars, clustering and unsupervised methods, log-linear and discriminative models, and the EM algorithm as applied within NLP

Reference Books:	
1.	Features of a Corpus, Niladri Sekhar Dash and S. Arulmozi, Springer Singapore, 2018, pp. 17–34. ISBN: 978-981-10-7458-5. doi: 10.1007/978- 981- 10- 7458- 5_2, url:https://doi.org/10.1007/978981-10-7458-5_2.
2.	Deep Learning, Ian Goodfellow, YoshuaBengio, and Aaron Courville, 2016, MIT Press, ISBN: *9780262035613*, http://www.deeplearningbook.org.
3.	Handbook of natural language processing, NitinIndurkhya and Fred J Damerau, 2010, Chapman and Hall/CRC, *.ISBN*-13 : 978-1420085921.
4.	Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Daniel Jurafsky and James H. Martin, 2000, 1st Upper Saddle River, NJ, USA: Prentice Hall PTR,. ISBN: 0130950696.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**-**	**-**	**1**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**1**	**2**	**3**
CO3	**2**	**2**	**2**	**3**	**2**	**1**	**-**	**1**	**3**	**1**	**2**	**2**
CO4	**2**	**3**	**3**	**2**	**2**	**1**	**1**	**3**	**1**	**1**	**-**	**2**

High-3: Medium-2: Low-1

Semester: V						
INTRODUCTION TO ROBOTICS **(Group A: PROFESSIONAL ELECTIVES, MOOC COURSE)**						
Course Code	**:**	**18CS5A4**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to

1.	To learn basics of robotics and to see how they can build robots and robotic aplications using advanced technologies. The course prepares them to take advanced course in robotics later.
2.	To study robotic applications in manufacturing industry, underwater, rehabilitation, medical and other areas.
3.	To study robotic mechanisms - kinematics
4.	To study different electrical actuators used in robotics- Motors, sensors and control
5.	To study computer science aspects of robotics like perception, localization and mapping, probabilistic robotics and path planning.

Unit – I	**8Hrs**
Introduction to robotics – History , growth; Robot Applications- Manufacturing industry, defense, rehabilitation, medical etc., Laws of robotics.Robot mechanisms; kinematics – coordinate transformations, DH parameters	
Unit – II	**8Hrs**
Forward kinematics and inverse kinematics ; Jacobians, Statics and Trajectory Planning. Actuators (electrical)- DC Motors, BLDC Servo motors;	
Unit – III	**8 Hrs**
Sensors, Sensor integration; Control – PWM, joint motion control, feedback control; Computed torque control.	
Unit – IV	**8 Hrs**
Perception, Localization and mapping; Probabilistic robotics, path planning, BFS; DFS;Dijkstra; A-star ; D-star; Voronoi; Potential field; Hybrid approaches	
Unit – V	**7 Hrs**
Simultaneous localization and mapping ; introduction to reinforcement learning	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Study robotic applications in manufacturing industry, underwater, rehabilitation, medical and other areas.
CO 2:	Learn Robot mechanisms; kinematics; Jacobians, Statics and Trajectory Planning.
CO 3:	Understand the working of Actuators (electrical)- DC Motors, BLDC Servo motors, Sensors and Control mechanisms.
CO 4:	Application of computer algorithmic aspects to robots like Perception, Localization and mapping; Probabilistic robotics, path planning and introduction to reinforcement learning

Reference Books:	
1.	Fundamentals of Robotics, Robert J Schilling, Pearson India, 2015ISBN : 978-93-325-5523-5
2.	Introduction to Robotics: Mechanics and control, John J Craig, 3e,Pearson India, 2005; ISBN: 0-13-123629-6
3.	Introduction to autonomous robots, Nikolauscorrell,ISBN-13:978-0692700877

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**1**			**3**	**2**		**2**	**3**	**2**	**3**
CO2	**3**	**3**	**2**		**2**	**1**	**2**		**1**	**2**	**2**	**2**
CO3	**3**	**3**	**2**		**2**	**1**	**2**		**1**	**2**	**2**	**2**
CO4	**3**	**3**	**2**		**3**	**1**	**2**		**1**	**2**	**2**	**2**

High-3: Medium-2: Low-1

Semester: V						
THE JOY OF COMPUTING USING PYTHON (Group A:PROFESSIONAL ELECTIVES, MOOC COURSE) (Common to All Branches)						
Course Code	:	**18CS5A5**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to

1.	Understand why Python is a useful scripting language for developers.
2.	Learn how to use lists, tuples, and dictionaries in Python programs.
3.	Define the structure and components of a Python program.
4.	Develop cost-effective robust applications using the latest Python trends and technologies

Unit – I	**8 Hrs**
Motivation for Computing, Welcome to Programming!!,Variables and Expressions : Design your own calculator, Loops and Conditionals : Hopscotch once again. Lists, Tuples and Conditionals : Let's go on a trip, Abstraction Everywhere : Apps in your phone.	
Unit – II	**8 Hrs**
Counting Candies : Crowd to the rescue, Birthday Paradox : Find your twin, Google Translate : Speak in any Language, Currency Converter : Count your foreign trip expenses.	
Unit – III	**8 Hrs**
Monte Hall : 3 doors and a twist, Sorting : Arrange the books, Searching : Find in seconds, Substitution Cipher : What's the secret !!,Sentiment Analysis : Analyse your Facebook dataPermutations : Jumbled Words,Spot the similarities : Dobble game	
Unit – IV	**8 Hrs**
Count the words : Hundreds, Thousands or Millions, Rock, Paper and Scissor : Cheating not allowed !!, Lie detector : No lies, only TRUTH , Calculation of the Area : Don't measure, Six degrees of separation, Image Processing : Fun with images	
Unit – V	**7 Hrs**
Tic tac toe : Let's play, Snakes and Ladders : Down the memory lane, Recursion : Tower of Hanoi, Page Rank : How Google Works !!	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Explore and apply the concept of python to solve real world problems.
CO 2:	Design Classes and establish relationships among Classes for various applications from problem definition.
CO 3:	Develop applications using google translator and gaming application.
CO 4:	Implement real time application such as browser automation, NLP, Image processing etc using python

Reference Books:	
1.	Head First Python,Paul Barry,10th Edition,2016,O'Reilly , ISBN 978-9352134823.
2.	Python Cookbook: Recipes for Mastering Python 3,David Beazley, Brian K. Jones, 9th Edition, 2017,O'Reilly,ISBN 978-1449340377.
3.	Python: The Complete Reference, Martin C Brown,7th Edition,2018,McGraw Hill Education, ISBN 978-9387572942.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**2**
CO2	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**2**
CO4	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**2**

High-3: Medium-2: Low-1

Semester: V						
FUNDAMENTALS OF AEROSPACE ENGINEERING **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B01**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:

1	Understand the history and basic principles of aviation
2	Demonstrate and explain foundation of flight, aircraft structures, material, aircraft propulsion
3	Comprehend the importance of all the systems and subsystems incorporated on an air vehicle
4	Appraise the significance of all the subsystems in achieving a successful flight

Unit-I	**08 Hrs**
Introduction to Aircraft: History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, Anatomy of an aircraft & Helicopters, Basic components and their functions, Simple Problems on Standard Atmospheric Properties.	
Unit – II	**08 Hrs**
Basics of Aerodynamics: Bernoulli's theorem, Centre of pressure, Lift and drag, Types of drag, Aerodynamic Coefficients, Aerodynamic centre, Wing Planform Geometry, Airfoil nomenclature, Basic Aerodynamic characteristics of airfoil, NACA nomenclature, Simple problems on lift and drag.	
Unit -III	**07 Hrs**
Aircraft Propulsion: Introduction, Classification of power plants, Gas Turbine Engine: Brayton Cycle, Principle of operation of turbojet, turboprop, turbofan engines, ramjet and scramjet engines, Comparative merits and demerits of different types Engines.	
Unit -IV	**09 Hrs**
Introduction to Space Flight: The upper atmosphere, Introduction to basic orbital mechanics, Kepler's Laws of planetary motion, Orbit equation, and Space vehicle trajectories**.** **Rocket Propulsion:** Principles of operation of rocket engines, Rocket Equation, Types of rockets: Solid, Liquid and Hybrid Propellant Rockets, Rocket Performance parameters: Thrust, Specific Impulse, Exhaust Velocity, Simple Problems on rocket performance.	
Unit -V	**07 Hrs**
Aerospace Structures and Materials: Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Structure of Wing and Fuselage and its basic construction.	

Course Outcomes: At the end of this course the student will be able to:

CO1:	Appreciate and apply the basic principles of aviation
CO2:	Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft propulsion and aircraft materials during the development of an aircraft
CO3:	Comprehend the complexities involved during development of flight vehicles.
CO4:	Evaluate and criticize the design strategy involved in the development of airplanes

Reference Books

1	Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Rocket Propulsion Elements, Sutton G.P., 8th Edition, 2011, John Wiley, New York, ISBN: 1118174208, 9781118174203.

3	Fundamentals of Compressible Flow, Yahya, S.M, 5th Edition, 2016, New Age International, ISBN: 8122440223
4	Aircraft structural Analysis, T.H.G Megson, 2010, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	3	2	2	-	-	-	1
CO2	2	2	2	3	2	1	1	1	-	-	-	1
CO3	1	-	3	3	-	-	-	-	-	-	-	1
CO4	2	2	3	3	-	2	2	2	-	-	-	1

High-3: Medium-2: Low-1

Semester: V						
NANOTECHNOLOGY **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B02**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basic knowledge of nanomaterials and the process to synthesize and characterize the nanoparticles.
2	Learn about Nano sensors and their applications in mechanical, electrical, electronic, magnetic, chemical fields.
3	Apply the concept of nanotechnology in sensing, transducing and actuating mechanism.
4	Design the nanoscale products used in multidisciplinary fields.

Unit-I	**08 Hrs**
Introduction to Nanomaterials: History of Nanotechnology, structures and properties of carbon based, metal based, bio-nanomaterails and hybrids: Bucky Ball, Nanotubes, Diamond like carbon(DLC), Quantum Dots, Nano Shells, Dendrimers, Nanocarriers, Nanocrystals, hybrid biological/inorganic, protein & DNA based nanostructures. Nanosafety Issues: Toxicology health effects caused by nanoparticles.	
Unit – II	**09 Hrs**
Nano Synthesis and Fabrication: Introduction & overview of Nanofabrication: Bottom up and Top down approaches using processes like Ball milling, Sol-gel Process, and Chemical Vapour deposition (CVD), electrodeposition and various lithography techniques (Hard & Soft lithography). **Characterization of Nanostructures:** Spectroscopy - UV-Visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscopy, X-ray spectroscopy. Electron Microscopy - Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM). Scanning Probe Microscopy - Atomic Force microscopy (AFM), Scanning Tunnel Microscopy (STM).	
Unit –III	**08 Hrs**
Nanosensors: Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, Mechanics of CNTs, Biosensors: Biosensors in modern medicine.	
Unit –IV	**07 Hrs**
Micro & Nano-Electromechanical systems and Microfluidics: MEMS/NEMS: Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. Microfluidics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps.	
Unit –V	**07 Hrs**
Applications of Nanotechnology: Molecular electronics, molecular switches, mechanical cutting tools, machine components, magnets, DLC coated grinding wheels. Electrical, electronic, solar cells, Batteries, fuel cells, Nanofilters. Medical nanotechnology: in Diagnostics, Therapeutics, Drug delivery and Nanosurgery. Nano in Agriculture- nanopesticides, nanofertilizers etc.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the structures of nano materials and their properties.
CO2:	Apply the various synthesis and fabrication methods and interpret the characterization results.
CO3:	Analyze the working mechanism of nanosensors and transducers and Apply its knowledge in various fields.
CO4:	Create and evaluate nano Design, Devices and Systems in various disciplines.

Reference Books	
1	B.S. Murty., P. Shankar., B.Raj, B..B. Rath, and J. Murday, Textbook of Nanosciences and Nanotechnology, Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII.1st Edition, 2013, ISBN- 978-3-642-28030-6.
2	V. K. Khanna, Nanosensors: Physical, Chemical and Biological, CRC press, 1st Edition, 2013, ISBN 9781439827123 (Unit III).
3	C. C. Kock., Nanostructured materials, Nanostructured materials, William Andrew Publishing, 2nd Edition, 2007, ISBN 0-8155-1534-0.
4	M. Wilson., K. Kannangara., G.Smith., M.Simmons., B. Raguse., Nanotechnology, , overseas Press (India) Private Ltd.,1st Edition, 2005,ISBN 81-88689-20-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	3	2	3	3	-	-	1	2	-
CO2	3	3	3	2	3	3	2	-	2	-	-	-
CO3	3	2	2	2	2	1	1	-	-	-	1	-
CO4	1	2	3	3	3	2	1	-	-	2	-	-

High-3: Medium-2: Low-1

Semester: V						
FUEL CELL TECHNOLOGY **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B03**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Recall the concept of fuel cells
2	Distinguish various types of fuel cells and their functionalities
3	Know the applications of fuel cells in various domains
4	Understand the characterization of fuel cells

Unit-I	**07 Hrs**
Introduction – I: Fuel cell definition, historical developments, working principle of fuel cell, components of fuel cell, EMF of the cell, Fuel Cell Reactions, fuels for cells and their properties	
Unit – II	**07 Hrs**
Types of fuel cells – II: Classification of fuel cells, alkaline fuel cell, polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, advantages and disadvantages of each	
Unit –III	**07 Hrs**
Efficiencies, losses and kinetics– III: Intrinsic maximum efficiency, voltaic efficiency, faradaic efficiency, overall efficiency, activation losses, fuel crossover and internal current, ohmic losses, mass transport/concentration losses, and activation/electrode/reaction kinetics	
Unit –IV	**08 Hrs**
Fuel Cell Characteristics – IV: In-situ characterization: I-V curve, current – voltage measurement, current interrupt measurement, cyclic voltammetry, electrochemical impedance spectroscopy Ex-situ characterization techniques: Proton conductivity, flexural strength, electrical conductivity, electrochemical surface area and electrochemical activity	
Unit –V	**10 Hrs**
Applications of fuel cells – V: Applications of fuel cells in air, road and rail transport, hydrogen storage, handling and safety issues. Production and storage of hydrogen	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the fundamentals and characteristics of fuel cells
CO2:	Apply chemical engineering principles to distinguish fuel cells from conventional energy systems
CO3:	Analyze the performance of fuel cells using different characterization techniques
CO4:	Evaluate the possibility of integrating fuel cell systems with conventional energy systems

Reference Books	
1	Fuel Cells – Principles and Applications, Viswanathan and M Aulice Scibioh, 1st Edition, 2009, Universities Press, ISBN – 13: 978 1420 060287
2	Fuel Cell Systems Explained, James Larminie and Andrew Dicks, 2nd Edition, 2003, John Wiley & Sons, ISBN – 978 0470 848579

3	Fuel Cell Fundamentals, O 'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, 1st Edition, 2006, Wiley, New York, ISBN – 978 0470 258439
4	Recent Trends in Fuel Cell Science and Technology, Basu. S, 1st Edition, 2007, Springer, ISBN – 978 0387 688152

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	-	-	-	1	-	1	-	-	-
CO2	2	-	2	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	3	-	2	-	-	-
CO4	-	2	2	-	-	-	2	-	3	-	-	2

High-3: Medium-2: Low-1

Semester: V						
INTELLIGENT SYSTEMS **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B04**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1.	Understand fundamental AI concepts and current issues.
2.	Understand and apply a range of AI techniques including search, logic-based reasoning, neural networks and reasoning with uncertain information.
3.	Recognize computational problems suited to an intelligent system solution.
4.	Identify and list the basic issues of knowledge representation, blind and heuristic search.

Unit – I	**07 Hrs**
Introduction: The Foundations of Artificial Intelligence, History of Artificial Intelligence, The State of the Art, **Intelligent Agent:** Introduction, How Agents Should Act, Structure of Intelligent Agents, **Problem-solving**: Solving Problems by Searching Search Strategies, Avoiding Repeated States, Avoiding Repeated States	
Unit – II	**08 Hrs**
Informed Search Methods: Best-First Search, Heuristic Functions, Memory Bounded Search, Iterative Improvement Algorithms **Game Playing:** Introduction: Games as Search Problems, Perfect Decisions in Two-Person, Games Imperfect Decisions, Alpha-Beta Pruning, Games That Include an Element of Chance	
Unit – III	**08 Hrs**
Knowledge Inference Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayes Rule, Uncertainty Principles, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	
Unit – IV	**08 Hrs**
Learning from Observations: A General Model of Learning Agents, Inductive Learning, Learning Decision Trees, Using Information Theory, Learning General Logical Descriptions, Why Learning Works: Computational Learning Theory **Reinforcement Learning:** Passive Learning in a Known Environment, Passive Learning in an Unknown Environment, Active Learning in an Unknown Environment	
Unit – V	**08 Hrs**
Expert Systems, Components, Production rules, Statistical reasoning, certainty factors, measure of belief and disbelief, Meta level knowledge, Introspection. Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand and explore the basic concepts and challenges of Artificial Intelligence.
CO 2:	Analyze and explain basic intelligent system algorithms to solve problems.
CO 3:	Apply Artificial Intelligence and various logic-based techniques in real world problems.
CO 4:	Assess their applicability by comparing different Intelligent System techniques

Reference Books:	
1.	AI – A Modern Approach, Stuart Russel, Peter Norvig, 3rd Edition, 2010, Pearson Education, ISBN-13: 978-0-13-604259-4
2.	Artificial Intelligence (SIE), Kevin Night, Elaine Rich, Nair B., 3rd Edition, 2008, McGraw Hill, ISBN: 9780070087705
3.	Introduction to AI and ES, Dan W. Patterson, Pearson Education, 3rd Edition, 2007, ISBN-13: 978-0134771007
4.	Introduction to Expert Systems, Peter Jackson, 4th Edition, Pearson Education, 2007, ISBN-13: 978-8131709337

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	2	2	1	2	-	2	2
CO2	3	3	3	3	3	2	2	1	2	-	2	2
CO3	3	3	3	3	3	2	1	1	2	-	2	2
CO4	3	3	3	3	3	1	2	1	1	1	2	2

High-3: Medium-2: Low-1

Semester: V						
REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B05**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand concept of using photographic data to determine relative positions of points.
2	Study the methods of collection of land data using Terrestrial and Aerial camera.
3	Analyze the data gathered from various sensors and interpret for various applications.
4	Apply the principles of RS, GIS and GPS in various scopes of Civil Engineering.

Unit-I	**07 Hrs**
Remote Sensing- Definition, types of remote sensing, components of remote sensing, electromagnetic spectrum, Black body, Atmospheric windows, energy interaction with earth surface features. Spectral reflectance curve. Platforms and sensors. Sensor resolutions. Types of satellites- Indian and other remote sensing satellites (IRS, IKONS and Landsat). Principle of visual interpretation - key elements.	
Unit – II	**08 Hrs**
Photogrammetry: Introduction types of Photogrammetry, Advantages Photogrammetry, Introduction to digital Photogrammetry. **Aerial Photogrammetry:** Advantages over ground survey methods- geometry of vertical photographs, scales of vertical photograph. Ground coordination- relief displacement, scale ground coordinates – flight planning.	
Unit –III	**08 Hrs**
Geographic Information System- Introduction, Functions and advantages, sources of data for GIS. Database – Types, advantages and disadvantages. Data Analysis.-overlay operations, network analysis, spatial analysis. Outputs and map generation. **GPS**- components and working principles.	
Unit –IV	**08 Hrs**
Applications of GIS, Remote Sensing and GPS: Water Resources engineering and management (prioritization of river basins, water perspective zones and its mapping), Highway and transportation (highway alignment, Optimization of routes, accident analysis), Environmental Engineering (Geo-statistical analysis of water quality, rainfall).	
Unit –V	**08 Hrs**
Applications of GIS, Remote Sensing and GPS: Urban Planning & Management, urban sprawl, Change detection studies, forests and urban area, agriculture, Disaster Management. Layouts: Dead end, Radial, Grid iron, Circular system.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand and remember the principle of Remote Sensing (RS) and Geographical Information Systems (GIS) data acquisition and its applications.
CO2:	Apply RS and GIS technologies in various fields of engineering and social needs

CO3:	Analyze and evaluate the information obtained by applying RS and GIS technologies.
CO4:	Create a feasible solution in the different fields of application of RS and GIS

Reference Books	
1	Geographic Information System-An Introduction, Tor Bernharadsen, 2009, 3rd Edition, Wiley India Pvt. Ltd. New Delhi, ISBN - 9788126511389.
2	Principles of Remote sensing and Image Interpretation, Lillesand and Kiefer, 2011, 6th Edition, John Wiley Publishers, New Delhi, ISBN – 8126532238.
3	Higher Surveying, Chandra A.M, 2015, 3rd Edition, New age international (P) Ltd, ISBN: 8122438121
4	Remote Sensing, Robert A. Schowengerdt, 2009, 3rd Edition, Elsevier India Pvt Ltd, New Delhi.
5	Remote Sensing and GIS, Bhatta B, 2011, Oxford University Press, New Delhi, ISBN - 0198072392

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	-	-	-	-	1	-	-	-	-	-	-
CO2	2	1	-	-	1	1	-	-	-	-	-	-
CO3	2	2	1	-	2	1	1	-	-	-	-	1
CO4	2	2	1	-	3	2	2	-	-	-	1	1

High-3: Medium-2: Low-1

Semester: V						
AUTOMOTIVE ELECTRONICS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B06**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Acquire the knowledge of automotive domain fundamentals, need of Electronics and communication interfaces in Automotive systems.
2	Apply various types of sensors, actuators and Motion Control techniques in Automotive systems
3	Understand digital engine control systems and Embedded Software's and ECU's used in automotive systems.
4	Analyse the concepts of Diagnostics, safety and advances in Automotive electronic Systems.

UNIT-I	**08 Hrs**

Fundamentals of Automotive: Evolution and Use of Electronics in Automotive, Automotive Systems, The Engine, Engine Control, Internal Combustion Engines, Spark Ignition Engines and Alternative Engines. Ignition System, Ignition Timing, Drivetrain, Suspensions, Brakes and Steering Systems.

Basics of electronic engine control: Motivation for Electronic Engine Control, Concept of an Electronic Engine control system, Definition of General terms, Definition of Engine performance terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition.

UNIT-II	**07 Hrs**

Automotive Sensors and Actuators:

Automotive Control System Applications of Sensors and Actuators,

Sensors: Air Flow Sensor, Engine Crankshaft Angular Position Sensor, Throttle Angle Sensor, Temperature Sensor, Sensors for Feedback Control, Sensors for Driver Assistance System: Radar, Lidar, Video Technology.

Actuators: Solenoids, Piezo Electric Force Generators, Fluid mechanical Actuators**,** Electric Motors and Switches.

UNIT-III	**08 Hrs**

Digital Engine Control Systems: Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control - Closed Loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System.

Vehicle Motion Control: Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS), Electronic Suspension System, Electronic Steering Control.

UNIT-IV	**08 Hrs**

Automotive Communication Systems:

Automotive networking: Bus systems, Technical principles, network topology. Buses in motor vehicles: CAN, Flex Ray, LIN, Ethernet, IP, PSI5, MOST, D2B and DSI.

Automotive Embedded Software Development

Fundamentals of Software and software development lifecycles. Overview of AUTOSAR methodology and principles of AUTOSAR Architecture.

UNIT-V	08 Hrs
Diagnostics and Safety in Automotive: Timing Light, Engine Analyzer, Electronic Control System Diagnostics: Onboard diagnostics, Off-board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag systems, Case study on ON-BOARD, OFF-BOARD diagnostics. **Advances in Automotive Electronic Systems:** Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Navigation: Navigation Sensors, Radio Navigation, dead reckoning navigation, Video based driver assistance systems, Night vision Systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Acquire the knowledge of automotive domain fundamentals, need of Electronics and communication interfaces in Automotive systems.
CO2:	Apply various types of sensors, actuators and Motion Control techniques in Automotive systems
CO3:	Analyze digital engine control systems and Embedded Software's and ECU's used in automotive systems.
CO4:	Illustrate the concepts of Diagnostics, safety and advances in Automotive electronic Systems.

Reference Books	
1.	Understanding Automotive Electronics, Williams. B. Ribbens, 6th Edition, 2003, Elsevier science, Newness publication, ISBN-9780080481494.
2.	Automotive Electronics Handbook, Robert Bosch, 2004, John Wiley and Sons, ISBN-0471288357
3.	Automobile Electrical and Electronic Systems, Tom Denton, 3rd Edition, Elsevier Butterworth-Heinemann. ISBN 0-7506-62190.
4.	Advanced Automotive Fault Diagnosis, Tom Denton, 2nd Edition, Elsevier Butterworth-Heinemann. ISBN 0-75-066991-8.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**2**	**1**	**-**	**1**
CO2	**3**	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**	**-**	**1**
CO3	**3**	**2**	**2**	**2**	**1**	**-**	**1**	**1**	**2**	**1**	**-**	**1**
CO4	**3**	**2**	**2**	**2**	**-**	**1**	**2**	**1**	**1**	**1**	**-**	**1**

High-3: Medium-2 : Low-1

Semester: V						
e- MOBILITY **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B07**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basics of electric and hybrid electric vehicles, their architecture and modelling.
2	Explain different energy storage technologies used for electric vehicles and their management system.
3	Describe various electric drives and its integration with Power electronic circuits suitable for electric vehicles.
4	Design EV Simulator through performance evaluation and system optimization techniques and need for the charging infrastructure.

Unit-I	**06 Hrs**
Electromobility and the Environment: A Brief History of the Electric Powertrain, Energy Sources for Propulsion and Emissions, The Advent of Regulations, Drive Cycles, BEV Fuel Consumption, Range, and mpge, Carbon Emissions for Conventional and Electric Powertrains, An Overview of Conventional, Battery, Hybrid, and Fuel Cell Electric Systems, A Comparison of Automotive and Other Transportation Technologies. **Vehicle Dynamics:** Vehicle Load Forces, Vehicle Acceleration, Simple Drive Cycle for Vehicle Comparisons	
Unit – II	**09 Hrs**
Batteries: Batteries Types and Battery Pack, Lifetime and Sizing Considerations, Battery Charging, Protection, and Management Systems, Battery Models, Determining the Cell/Pack Voltage for a Given Output\Input Power, Cell Energy and Discharge Rate. **Battery Charging:** Basic Requirements for Charging System, Charger Architectures, Grid Voltages, Frequencies, and Wiring, Charging Standards and Technologies, SAE J1772, Wireless Charging, The Boost Converter for Power Factor Correction.	
Unit -III	**10 Hrs**
Battery Management System: BMS Definition, Li-Ion Cells, Li-Ion BMSs, Li-Ion Batteries, BMS Options: Functionality, CCCV Chargers, Regulators, Balancers, Protectors, Functionality Comparison, Technology, Topology. **BMS Functions:** Measurement: Voltage, Temperature, Current, Management: Protection, Thermal Management, Balancing, Distributed Charging, Evaluation, External Communication: Dedicated analog and digital wires.	
Unit –IV	**07 Hrs**
Electric Drivetrain: Overview of Electric Machines, classification of electric machines used in automobile drivetrains, modelling of electric machines, Power Electronics, controlling electric machines, electric machine and power electronics integration Constraints.	
Unit –V	**07 Hrs**
EV Simulation: system level simulation, EV simulator, simulator modules, performance evaluation, system optimization. **EV Infrastructure:** Domestic charging infrastructure, Public charging infrastructure, Standardization and regulations, Impacts on power system.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and modelling.
CO2:	Discuss and implement different energy storage technologies used for electric vehicles and their management system.
CO3:	Analyze various electric drives and its integration techniques with Power electronic circuits suitable for electric vehicles.
CO4:	Design EV Simulator for performance evaluation and system optimization and understand the requirement for suitable EV infrastructure.

Reference Books	
1	Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, 1st Edition, 2018, Wiley, *ISBN* 9781119063667.
2	Battery Management system for large Lithium Battery Packs, Davide Andrea, 1st Edition, 2010, ARTECH HOUSE, ISBN-13 978-1-60807-104-3
3	Hybrid Vehicles from Components to System, F. BADIN, Ed, 1st Edition, 2013, Editions Technip, Paris, *ISBN 978-2-7108-0994-4.*
4	Modern Electric Vehicle Technology C.C. Chan and K.T. Chau, 1st Edition, 2001, Oxford university press, ISBN 0 19 850416 0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	2	2	2	3	-	2	-	-	1
CO2	3	3	3	3	3	3	3	-	2	2	1	-
CO3	2	3	3	3	3	2	3	-	2	1	1	-
CO4	3	3	3	3	3	2	3	2	2	-	1	-

High-3: Medium-2: Low-1

Semester: V						
SMART SENSORS & INSTRUMENTATION (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B08**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the fundamentals of transducers and sensors.
2	Demonstrate the working principles of different transducers and sensors.
3	Apply the principles of different type of sensors and transducers on state of art problems.
4	Create a system using appropriate transducers and sensors for a particular application.

Unit-I	**07 Hrs**
Introduction: Definition of a transducer, Block Diagram, Classification of Transducers, Advantages of Electrical transducers. **Resistive Transducers:** **Potentiometers:** Characteristics, Loading effect, and problems. **Strain gauge:** Theory, Types, applications and problems. **Thermistor, RTD:** Theory, applications and problems.	
Unit – II	**09 Hrs**
Thermocouple: Measurement of thermocouple output, compensating circuits, lead compensation, advantages and disadvantages of thermocouple. **LVDT:** Principle, Characteristics, Practical applications and problems. **Capacitive Transducers:** Capacitive transducers using change in area of plates, distance between plates and change of dielectric constants, Applications of Capacitive Transducers and problems	
Unit –III	**09 Hrs**
Piezo-electric Transducers: Principles of operation, expression for output voltage, Piezo-electric materials, equivalent circuit, loading effect, Frequency response and Problems. **Special Transducers:** Hall effect transducers, Thin film sensors, and smart transducers: Principles and applications, Introduction to MEMS Sensors and Nano Sensors, Schematic of the design of sensor, applications.	
Unit –IV	**07 Hrs**
Chemical sensors: pH value sensor, dissolved oxygen sensor, oxidation-reduction potential sensor, Zirconium probe Sensors, Chem FET sensors. **Photo sensors**: Photo resistor, Photodiode, Phototransistor, Photo-FET, Charge coupled device. **Tactile sensors:** Construction and operation, types.	
Unit –V	**07 Hrs**
Humidity Sensors and Moisture Sensors: Concept of humidity, Electrical Conductivity Sensors, Thermal Conductivity Sensors, Optical Hygrometer, Oscillating Hygrometer. **IR Sensors:** Golay cells, Thermopile, pyroelectric sensor, bolometers, Active Far-Infrared Sensors, Gas flame detectors	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic principles of different transducers and sensors.
CO2:	Apply the knowledge of transducers and sensors to comprehend digital instrumentation systems.
CO3:	Analyze and evaluate the performance of different transducers and sensors for various applications.
CO4:	Create a system using appropriate transducers and sensors for a particular application.

Reference Books	
1	Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, 4th Edition 2008, PHI Publication, ISBN: 978-1-4419-6465-6.
2	Clarence W.de Silva, Sensors and Actuators: Control systems Instrumentation, 2013 Edition, CRC Press, ISBN: 978-1-4200-4483-6.
3	A.K. Sawhney, Electrical and Electronic Measurements and Instrumentation, 18th Edition, 2008, Dhanpat Rai and Sons, ISBN: 81-7700-016-0.
4	Transducers and Instrumentation, D.V.S. Murthy, 2nd Edition 2008, PHI Publication, ISBN: 978-81-203-3569-1.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks are executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	2	2	-	-	-	-	-	-
CO3	1	2	2	-	1	1	-	-	-	-	-	2
CO4	-	-	-	-	1	1	-	-	-	3	-	1

High-3: Medium-2: Low-1

Semester: V						
OPERATIONS RESEARCH (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B09**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Develop the skills in the application of operations research models for complex decision-making situations.
2	Implement the methodology and tools of operations research to assist decision-making.

UNIT-I	**07 Hrs**
Introduction: OR methodology, Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR. **Linear Programming:**Definition, Mathematical Formulation, Standard Form, Solution Space, Types of solution - Basic Feasible, Degenerate, Solution through Graphical Method. Usage of software tools to demonstrate LPP (demonstrations and assignments only)	
UNIT-II	**10Hrs**
Simplex Method & Sensitivity Analysis: Simplex methods, Artificial Stating Solution - M Method & Two phase method, Sensitivity Analysis - Graphical sensitivity analysis, Algebraic sensitivity analysis. Interpretation of graphical output from software packages such as MS Excel	
UNIT-III	**10 Hrs**
Transportation Problem: Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Variants in Transportation Problems, Applications of Transportation problems. **Assignment Problem:** Formulation of the Assignment problem, Solution method of assignment problem-Hungarian Method, Solution method of assignment problem-Hungarian Method, Variants in assignment problem, Traveling Salesman Problem. Usage of software tools to demonstrate Transportation and Assignment problems	
UNIT-IV	**06 Hrs**
Project Management Using Network Analysis: Network construction, Determination of critical path and duration, floats, CPM - Elements of crashing, Usage of software tools to demonstrate N/W flow problems	
UNIT-V	**06 Hrs**
Game Theory: Introduction, Two person Zero Sum game, Pure strategies – Games with saddle point, Graphical Method, The rules of dominance, solution method of games without saddle point, Arithmetic method.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic concepts of different models of operations research and their applications.
CO2:	Build and solve Transportation Models and Assignment Models.
CO3:	Design new simple models, like: CPM, MSPT to improve decision –making and develop critical thinking and objective analysis of decision problems.
CO4:	

Reference Books	
1	Operation Research an Introduction, Taha H A, 8th Edition, 2004, PHI, ISBN:0130488089.
2	Operations Research: Principles and Practice, Ravindran, Phillips, Solberg, 2nd Edition, 2007, John Wiley & Sons, ISBN: 8126512563
3	Introduction to Operation Research, Hiller and Liberman, 8th Edition, 2004, Tata McGraw Hill, ISBN: 0073017795.
4	Operations Research Theory and Application, J K Sharma,2nd Edition, 2003, Pearson Education Pvt Ltd, ISBN: 0333-92394-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	3	2	2	-	-	-	1	-	-	1
CO2	-	2	-	-	-	-	-	-	-	1	-	1
CO3	2	-	-	2	2	-	-	1	-	-	-	-
CO4												

High-3: Medium-2: Low-1

Semester: V						
MANAGEMENT INFORMATION SYSTEMS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To understand the basic principles and working of information technology.
2	Describe the role of information technology and information systems in business.
3	To contrast and compare how internet and other information technologies support business processes.
4	To give an overall perspective of the importance of application of internet technologies in business administration.

Unit-I	**08 Hrs**
Information systems in Global Business Today: The role of information systems in business today, Perspectives on information systems, Contemporary approaches to information systems, Hands-on MIS projects. **Global E-Business and Collaboration**: Business process and information systems, Types of business information systems, Systems for collaboration and team work, The information systems function in business. A Case study on E business.	
Unit – II	**08 Hrs**
Information Systems, Organizations and Strategy: Organizations and information systems, How information systems impact organization and business firms, Using information systems to gain competitive advantage, management issues, **Ethical and Social issues in Information Systems**: Understanding ethical and Social issues related to Information Systems, Ethics in an information society, The moral dimensions of information society. A Case study on business planning.	
Unit –III	**08 Hrs**
IT Infrastructure and Emerging Technologies: IT infrastructure, Infrastructure components, Contemporary hardware platform trends, Contemporary software platform trends, Management issues**. Securing Information Systems**: System vulnerability and abuse, Business value of security and control, Establishing framework for security and control, Technology and tools for protecting information resources. A case study on cybercrime.	
Unit –IV	**08 Hrs**
Achieving Operational Excellence and Customer Intimacy: Enterprise systems, Supply chain management (SCM) systems, Customer relationship management (CRM) systems, Enterprise application. **E-commerce: Digital Markets Digital Goods**: E-commerce and the internet, E-commerce-business and technology, The mobile digital platform and mobile E-commerce, Building and E-commerce web site. A Case study on ERP.	
Unit –V	**07 Hrs**
Managing Knowledge: The knowledge management landscape, Enterprise-wide knowledge management system, Knowledge work systems, Intelligent techniques. **Enhancing Decision Making**: Decision making and information systems, Business intelligence in the enterprise. Business intelligence constituencies. **Building Information Systems**: Systems as planned organizational change, Overview of systems development.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand and apply the fundamental concepts of information systems.
CO2:	Develop the knowledge about management of information systems.
CO3:	Interpret and recommend the use information technology to solve business problems.
CO4:	Apply a framework and process for aligning organization's IT objectives with business strategy.

Reference Books	
1	Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm, Pearson Education, 14th Global edition, 2016, ISBN:9781292094007.
2	James A. O' Brien, George M. Marakas: Management Information Systems, Global McGraw Hill, 10th Edition, 2011, ISBN: 978-0072823110.
3	Steven Alter: Information Systems, The Foundation of E-Business, Pearson Education, 4th Edition, 2002, ISBN:978-0130617736.
4	W.S. Jawadekar: Management Information Systems, Tata McGraw Hill, 2006, ISBN: 9780070616349.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	3	-	-	-	-	-	-	-	1	-	1
CO3	3	3	1	-	2	-	-	-	-	1	-	1
CO4	3	3	2	1	2	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

V Semester						
AUTOMOTIVE MECHATRONICS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B11**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Identify various Mechatronics systems of a modern automobile
2	Describe how the proper quantity/grade of fuel affects engine performance.
3	Understand Bharat-VI / EURO-VI emission norms
4	Apply the knowledge of engineering and science to analyse the performance of Mechatronics system
5	Analyse vehicle sub-systems comprising of sensors and actuators

Unit-I	**06 Hrs**
Automobile Engines Classifications of Internal Combustion Engines**.** Engine nomenclature and mechanics. Mixture formation and direct fuel injection – homogeneous and stratified injection. Thermodynamic principles of Otto and Diesel cycle. Operation, characteristics and energy yield in a 4-stroke engine. Fuels: Gasoline, Diesel, LPG and Natural Gas for automotive applications. Fuel properties- Octane number and Cetane number.	
Unit-II	**10 Hrs**
Engine Auxiliary Systems: Air Intake and Exhaust System (Bharat Stage –VI norms) **-** Intake manifold, Turbocharger, Intercooler, Exhaust manifold, 3-way and oxidation catalytic convertor, Exhaust Gas Recirculation system. **Common Rail Fuel Injection system**- Low pressure and high-pressure fuel systems, Return line, Quantity control valve, Injectors – solenoid and piezo injectors.	
Unit-III	**10 Hrs**
Vehicular Auxiliary Systems: Vehicle frame and body classification- Hatchback, Sedan, SUV, Coupe, Roadster. Adaptive Brakes - Disc and drum brakes, Antilock Braking Systems, ESP, TCS. Wheels and Tyres- Toe-In, Toe-Out, Caster and Camber angle. Classification of tyres, Radial, Tubeless. **Supplemental Restraint System**: Active and passive safety, Vehicle structure, Gas generator and air bags, Belt Tensioner, Acceleration sensor, Rollover sensor, Seat occupancy recognition.	
Unit-IV	**07 Hrs**
Principles of motor vehicle electronics – Basic structure of control units, Functions of control units and On-Board Diagnostic kit. **Telematics in vehicles** – Radio Transmission, Interference and signal processing. Lubrication and cooling system- Components, working principle, Properties, Viscosity.	
Unit-V	**06 Hrs**
Sensors: Oxygen sensors, Crankshaft Angular Position Sensor, Manifold Absolute Pressure Sensor, Coolant Temperature Sensor, Hot Film Mass Air flow Sensor, Throttle Position Sensor.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe the functions of Mechatronic systems in a modern automobile
CO2:	Evaluate the performance of an engine by its parameters
CO3:	Analyse the automotive exhaust pollutants as per emission norms
CO4:	Demonstrate communication of control modules using a On-Board Diagnostic kit

Reference Books	
1.	Automotive Technology – A systems approach, Jack Erjavec, 5th Edition, Delamr Cengage Learning, ISBN-13: 978-1428311497
2.	Automotive Engineering Fundamentals, Richard Stone and Jeffrey K. Ball, 2004, SAE International, ISBN: 0768009871
3.	Bosch Automotive Handbook, Robert Bosch, 9th Edition, 2004, ISBN: 9780768081527
4.	Understanding Automotive Electronics, William B Ribbens, 5th Edition, Butterworth–Heinemann, ISBN 0-7506-7008-8

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30 (Q) + 50 (T) + 20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	2	1	2	1	-	-	1	2	3	-	-
CO2	2	1	2	1	3	-	-	2	2	3	-	-
CO3	1	2	2	1	2	-	-	2	2	3	-	-
CO4	1	2	2	1	2	-	-	2	2	1	-	1

High-3: Medium-2: Low-1

Semester: V						
TELECOMMUNICATION SYSTEMS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B12**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Represent schematic of communication system and identify its components.
2	Classify satellite orbits and sub-systems for communication.
3	Analyze different telecommunication services, systems and principles.
4	Explain the role of optical communication system and its components.
5	Describe the features of wireless technologies and standards

UNIT-I	**06 Hrs**
Introduction to Electronic Communication: The Significance of Human Communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, Electromagnetic Spectrum, Bandwidth, A Survey of Communication Applications. **The Fundamentals of Electronics:** Gain, Attenuation, and Decibels. **Radio Receivers:** Super heterodyne receiver.	
UNIT-II	**10 Hrs**
Modulation Schemes: Analog Modulation: AM, FM and PM- brief review. **Digital Modulation:** PCM, Line Codes, ASK, FSK, PSK. **Wideband Modulation:** Spread spectrum, FHSS, DSSS. **Multiple Access**: FDMA, TDMA, CDMA.	
UNIT-III	**09 Hrs**
Satellite Communication: Satellite Orbits, Satellite Communication Systems, Satellite Subsystems, Ground Stations, Satellite Applications, Global Positioning System.	
UNIT-IV	**07 Hrs**
Optical Communication: Optical Principles, Optical Communication Systems, Fiber-Optic Cables, Optical Transmitters and Receivers, Wavelength-Division Multiplexing, Passive Optical Networks.	
UNIT-V	**07 Hrs**
Cell Phone Technologies: Cellular concepts, Frequency allocation, Frequency reuse, Internet Telephony, The Advanced Mobile Phone System [AMPS]. **Wireless Technologies:** Wireless LAN, PANs and Bluetooth, ZigBee and Mesh Wireless Networks.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the basics of communication systems.
CO2	Analyze the importance of modulation and multiple access schemes for communication systems.
CO3	Analyze the operational concept of cell phone and other wireless technologies.
CO4	Justify the use of different components and sub-system in advanced communication systems.

Reference Books	
1	Principles of Electronic Communication Systems, Louis E. Frenzel, 4th Edition, 2016, Tata McGraw Hill, ISBN: 978-0-07-337385-0.
2	Electronic Communication Systems, George Kennedy, 3rd Edition, 2008, Tata McGraw Hill, ISBN: 0-02-800592-9.
3	Introduction to Telecommunications, Anu A. Gokhale, 2nd Edition, 2008, Cengage Learning ISBN: 981-240-081-8.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	-	1	1	-	-	-	1	-	-	-
CO2	2	1	-	1	1	-	-	-	1	-	-	-
CO3	2	1	-	1	1	-	-	-	2	-	-	-
CO4	1	1	-	1	1	1	-	-	1	-	-	-

High-3: Medium-2: Low-1

Semester: V						
QUANTUM MECHANICS OF HETERO/NANO STRUCTURES (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B13**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the role of Quantum mechanics in physical processes as we reduce dimensions.
2	Explain the design and performance of low dimensional semiconductors and their modelling.
3	Understand the differences observed in transport properties of low dimensional materials.
4	Apply the role of heterostructures in devices
5	Acquire the knowledge to design and develop smart devices and sensors that runs on the quantum technology.

Unit-I	**08 Hrs**
Review of Quantum Mechanics and Solid state Physics: Wave particle duality, Heisenberg's Uncertainty Principle, group velocity, Time independent and dependent Schrodinger Equation and its application, Perturbation theory, Fermi's Golden Rule. Free electron and Fermi gas model of solids, Density of states and its dependence on dimensionality, Bloch theorem in periodic structures, Dynamics of electrons and holes in bands, Effective mass, distinct regimes of conduction and the important parameters characterising it.	
Unit – II	**08 Hrs**
Basics of semiconductors and lower dimensions: Intrinsic and extrinsic semiconductors, electron and hole concentration. Mobility, Energy Diffusion, Continuity equations. Carrier life-times and Diffusion length. Degenerate semiconductors. Optical processes of semi-conductors, inter-band and intra-band process. Quantum wells of nanostructures of different geometries-Square, Parabolic, Triangular and their solutions, Quantum Dots, wires and wells (From 0-Dim to 3 Dim). Strained Layers and its effect on bands. Band structure/energy levels in Quantum Wells and Excitonic effects in them.	
Unit –III	**08 Hrs**
Quantum Nano structures and Quantum Transport: Architecture and working of n-channel MOSFET, metal – semiconductor contact(interface) in details, Homo-junction, Hetero-junction, Hetero-structures. Modulation and strain doped Quantum Wells. Super Lattice: Kronig Penney Model of a super-lattice, Tight Binding Approximation of a super lattice. The genesis of Quantum Transport: Parallel transport : scattering mechanism, experimental data(focus will be on GaAs), hot electrons. Perpendicular transport: Resonant tunneling. Electric field effect in super lattices: Stark effect.	
Unit –IV	**08 Hrs**
Transport in Nano-structures in electric and magnetic fields: Quantized conductance: Landauer Buttiker transmission formalism, Application of formalism to explain quantized conductance of devices like quantum point contacts. Aharonov-Bohm effect in gold rings and other systems. Violation of Kirchhoff's circuit laws for quantum conductors. Coulomb Blockade. Density of States of a 2D system in a magnetic field. Landau quantization of electrons in a magnetic field. Shubnikov-de Haas effect. Quantum Hall Effect-integer and quantum.	
Unit –V	**07 Hrs**
Applications in Opto-electronics and Spintronics: Lasers and photodetectors on quantum wells and quantum dots, High-mobility transistors, Ballistic-	

transport devices, Single-electron transistors**,** Optical properties of Quantum Wells and Superlattices, Quantum Dots and Nano crystals. Quantum confined Stark effect, Stark ladders, Bloch oscillations. Spintronics, transport of spin, spin valve, Giant Maneto-resistance, Spin Injection (Johnson-Silsbee experiments).

Course Outcomes: After completing the course, the students will be able to	
CO1:	After successful completion of the course the student will be able to identify the different domains of application of the concepts of Quantum mechanics in Nano structures, super-lattices and Photonics.
CO2:	The student will gain knowledge to understand the crucial physics layers and principles that are at the core of nano and meso technology.
CO3:	The student will be able to apply the concepts to solve problems (quantitative and qualitative)
CO4:	The student can apply the concepts in an interdisciplinary manner and can create new ideas and products related to appliances and sensors, that use the said concepts.

Reference Books	
1	The Physics of Low Dimensional Semiconductors an introduction, John H Davies, xxx Edition, 1998, Cambridge University Press, ISBN: 0-521-48491-X (pbk).
2	Introduction to Quantum Mechanics, David J Griffiths & Darrell F. Schroeter, 3rd Edition, 2018, Cambridge University Press, ISBN: 978-1107189638
3	Nanotechnology for Microelectronics and Optoelectronics, J.M. Martinez-Duert, R.J. Martin Palma and F. Agullo-Rueda, 1st Edition, 2006, Elsevier Press, ISBN: 9780080456959
4	Electronic Transport in Mesoscopic Systems, Supriyo Datta, 1st Edition,1997, Cambridge University Press ISBN: 9780521599436
5	Semiconductor Optoelectronic devices, Pallab Bhattacharya, 2nd Edition, 1996, Prentice Hall of India, ISBN: 978-0134956565
6	Semiconductor Devices, Physics and Technology, S. M. Sze, 2nd Edition, 2008, Wiley Student Edition, ISBN: 978-8126516810

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	1	3	2	2	-	-	-	1
CO2	3	3	3	2	1	2	1	1	-	-	-	1
CO3	3	3	3	2	1	1	1	1	-	-	-	1
CO4	1	2	1	2	1	2	2	1	2	2	-	1

High-3: Medium-2: Low-1

Semester: V						
THIN FILMS AND NANOTECHNOLOGY (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B14**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basics of thin films structure and property.
2	Acquire the knowledge of thin film preparation by various techniques and their characterization methods.
3	Apply the knowledge to select the most potential methods to produce thin films for wanted applications.
4	Asses typical thin film applications.

Unit-I	**08 Hrs**

Nanostructures and Nanomaterials:

Types of nanostructures and properties of nanomaterials: Introduction, Three dimensional, Two dimensional, One dimensional, Zero-dimensional nano-structured materials. Carbon Nano Tubes (CNT), Quantum Dots, shell structures, Multilayer thin films and super lattice clusters. Synthesis through Sol gel and Spray Pyrolysis. Mechanical-physical-chemical properties. Current trends and challenges of nanoscience and nanotechnology.

Unit – II	**08 Hrs**

Thin Film Preparation Methods:

Vacuum technology- Basics of Vacuum pumps and vacuum measurements, **Physical Vapour Deposition (PVD) Techniques:** Evaporation - Thermal evaporation, Electron beam evaporation, and Cathode arc deposition. **Sputtering:** DC sputtering, RF Sputtering, Magnetron sputtering, and Ion beam sputtering.

Unit –III	**08 Hrs**

Surface Preparation and Growth of Thin Films:

Nucleation – theoretical and experimental aspects. Surface preparation & Engineering for Thin film growth: Cleaning, Modification, Masking & Patterning, Base Coats and Top Coats. Thin Film growth: Sequence of thin film growth, Defects and impurities, Effect of Deposition Parameters on film growth. Properties of Thin Films: Adhesion, Thickness, Surface, Physical, Chemical and Mechanical.

Unit –IV	**08 Hrs**

Characterization of Thin Film Properties:

Film thickness measurement: Quartz crystal thickness monitor and Stylus Profiler methods. Surface morphology and topography by SEM, AFM. Film composition by X-ray Photoelectron Spectroscopy; Electrical characterization by Hall effect measurement, Four probe analyzer. Optical characterization – Ellipsometry, Raman Spectroscopy. Dielectric and Mechanical properties characterization.

Unit –V	**07 Hrs**

Thin Film Applications:

Band gap Engineering through thin films for electrical and optical applications. Thin Film for energy applications - coating on solar cells, fuel cells, batteries and super capacitors. Thin film thermo electric materials for thermal sensor applications. Thin film coating as protective coating for optical surfaces and as anti-reflection. Thin Film drug delivery and antibacterial surfaces - opportunities and challenges

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic mechanism of surface modification and thin film growth.
CO2:	Attain strong hold on thin film preparation by various techniques and their characterization methods.
CO3:	Apply the knowledge to select the most potential methods to produce thin films for wanted applications.
CO4:	Detailed knowledge of thin film selection for various applications.

Reference Books	
1	Thin Film Phenomenon, K.L.Chopra, 1st edition, 1969, McGraw-Hill ISBN-13**:** 978-0070107991.
2	Materials Science of Thin Films, Milton Ohring, 2nd Edition, Academic Press, 2002, ISBN 978-0-12-524975-1
3	Thin-Film Deposition: Principles and Practice, Donald Smith, 1st edition, 1994, McGraw-Hill College, ISBN-13: 978-0071139137.
4	Handbook of Thin-Film Technology, Hartmut Frey, Hamid R Khan Editors, 1st edition, 2015, Springer, ISBN 978-3-642-05429-7.
5	Nanostructures and Thin Films for Multifunctional Applications Technology, Properties and Devices, Ion Tiginyanu, Pavel Topala, Veaceslav Ursaki, 1st edition, 2016, Springer, ISBN 978-3-319-30197-6.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	-	-	-	-	-	-	-	-	2
CO2	3	2	2	2	-	-	-	-	-	-	-	2
CO3	2	3	3	2	-	1	1	1	-	-	-	2
CO4	2	3	3	2	1	2	2	2	2	2	-	2

High-3: Medium-2: Low-1

Semester: V						
ADVANCES IN CORROSION SCIENCE AND TECHNOLOGY (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B15**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the fundamental & socio, economic aspects of corrosion.
2	Identify practices for the prevention and remediation of corrosion.
3	Analyzing methodologies for predicting corrosion tendencies.
4	Evaluate various corrosion situations and implement suitable corrosion control measures.

Unit-I	**08 Hrs**

Introduction to corrosion and its effect

Introduction: The direct and indirect effects of corrosion, economic losses, Indirect losses -Shutdown, contamination, loss of product, loss of efficiency, environmental damage, Importance of corrosion prevention in various industries, corrosion auditing in industries, corrosion map of India.

Corrosion issues in specific industries-power generation, chemical processing industries, oil and gas Industries, pulp and paper plants, corrosion effect in electronic industry.

Unit – II	**08 Hrs**

Types of Electrochemical corrosion

Introduction: Galvanic series, Pilling-Bedworth ratio, Types: Galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, erosion corrosion, stress corrosion, season cracking, hydrogen embrittlement, high temperature corrosion, bacterial corrosion, corrosion in polymer (plastic) materials.

Crevice corrosion-mechanism of differential aeration corrosion, mixed potential theory for understanding common corrosion of metals and alloys.

Unit –III	**07 Hrs**

Corrosion in different engineering materials

Concrete structures, duplex, super duplex stainless steels, ceramics, composites.

Corrosion in Specific Materials: Corrosion of Iron, Nickel, Aluminium, Titanium and Super alloys.

Thermodynamics of Corrosion: Pourbaix diagram and its importance in metal corrosion and its calculation for Al, Cu, Ni and Fe.

Unit –IV	**07 Hrs**

Advances in Corrosion Control

Principles of corrosion prevention, material selection, design considerations, control of environment-decrease in velocity, passivity, removal oxidizer, Inhibitors and passivators, coatings- organic, electroplating of Copper, Nickel and Chromium, physical vapor deposition-sputtering, Electroless plating of Nickel.

Unit –V	**09 Hrs**

Corrosion Testing

Physio-chemical methods: Specimens, environment, evaluation of corrosion damage, Accelerated laboratory tests-salts spray, service tests.

Electrochemical methods: Electrode potential measurements, polarization measurements. Stern-Geary equation, Impedance measurements, Accelerated tests. Advantages and limitations of corrosion testing methods.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the causes and mechanism of various types of corrosion
CO2:	Identify, analyze and interpret corrosion with respect to practical situations.
CO3:	Apply the knowledge of chemistry in solving issues related to corrosion.
CO4:	Develop practical solutions for problems related to corrosion.

Reference Books	
1	Corrosion Engineering, M.G, Fontana, 3rd Edition, 2005, Tata McGraw Hill, ISBN: 978-0070214637.
2	Principles and Prevention of Corrosion, D. A Jones, 2nd Edition, 1996, Prentice Hall, ISBN: 978-0133599930.
3	Design and corrosion prevention, Pludek, 1978, McMillan, ISBN: 978-1349027897
4	Introduction to metal corrosion, Raj Narain, 1983, Oxford &IBH, ISBN: 8120402995.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	2	-	-	-	-	1	-	1
CO4	3	3	3	3	2	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

Semester: V						
COMPUTATIONAL ADVANCED NUMERICAL METHODS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B16**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Gain adequate exposure to learn alternative methods to solve algebraic and transcendental equations using suitable numerical techniques.
2	Use the concepts of interpolation techniques arising in various fields.
3	Solve initial value and boundary value problems which have great significance in engineering practice.
4	Apply the concepts of eigen value and eigen vector to obtain the critical values of various physical phenomena.
5	Demonstrate elementary programming language, implementation of algorithms and computer programs to solve mathematical problems.

Unit-I	**07 Hrs**
Algebraic and Transcendental Equations: Roots of equations in engineering practice - Fixed point iterative method, Aitken process, Muller method, Chebyshev method. Simulation using MATLAB.	
Unit – II	**07 Hrs**
Interpolation: Introduction to finite differences, Finite differences of a polynomial, Divided differences, Newton's divided difference interpolation formula, Hermite interpolation, Spline interpolation - linear, quadratic and cubic spline interpolation. Simulation using MATLAB.	
Unit –III	**08 Hrs**
Differential Equations I: Runge-Kutta and Runge-Kutta-Felhberg methods to solve differential equations, Boundary value problems (BVPs) - Rayleigh-Ritz method, Shooting method, Differential transform method to solve differential equations. Simulation using MATLAB.	
Unit –IV	**08 Hrs**
Differential Equations II: Solution of second order initial value problems - Runge-Kutta method, Milne method, Cubic spline method, Finite difference method for ordinary linear, Nonlinear differential equations, Simulation using MATLAB.	
Unit –V	**09 Hrs**
Eigen Value Problems: Eigen values and Eigen vectors, Power method, Inverse Power method, Bounds on Eigen values, Gershgorin circle theorem, Jacobi method for symmetric matrices, Given's method. Simulation using MATLAB.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify and interpret the fundamental aspects of different Mathematical concepts and corresponding computational techniques.
CO2:	Apply the knowledge and skills of computational techniques to solve different types of application problems.
CO3:	Analyze the physical problem and use appropriate method to solve numerically using computational techniques.
CO4:	Distinguish the overall mathematical knowledge gained to demonstrate and analyze the problems arising in engineering practice.

Reference Books	
1	Numerical methods for scientific and engineering computation, M. K. Jain, S. R. K. Iyengar and R. K. Jain, 6th Edition, 2012, New Age International Publishers, ISBN-13: 978-81-224-2001-2.
2	Numerical Analysis, Richard L. Burden and J. Douglas Faires, 9th Edition, 2012, Cengage Learning, ISBN-13: 978-81-315-1654-6.
3	Introductory Methods of Numerical Analysis, S. S. Sastry, 4th Edition, 2011, PHI Learning Private Ltd., ISBN: 978-81-203-2761-0.
4	Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, 5th Edition, 2011, Tata Mcgraw Hill, ISBN-10: 0-07-063416-5.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

Semester: V						
MATHEMATICS FOR MACHINE LEARNING (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B17**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basic knowledge on the fundamental concepts of linear algebra that form the foundation of machine intelligence.
2	Acquire practical knowledge of vector calculus and optimization to understand the machine learning algorithms or techniques.
3	Use the concepts of probability and distributions to analyze possible applications of machine learning.
4	Apply the concepts of regression and estimation to solve problems of machine learning.
5	Analyze the appropriate mathematical techniques for classification and optimization of decision problems.

Unit-I	**07 Hrs**
Linear Algebra: Review of Vector Spaces-Linear Independence, Basis, Rank and Linear Mappings. Affine Spaces, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations, Singular Value Decomposition.	
Unit – II	**07 Hrs**
Vector Calculus and Continuous Optimization: Gradients of Vector-Valued Functions, Gradients of Matrices, Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Linearization and Multivariate Taylor Series, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers and Convex Optimization.	
Unit –III	**08 Hrs**
Probability and Distributions: Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule and Bayes' Theorem, Gaussian Distribution, Conjugacy and the Exponential Family, Change of Variables - Inverse Transform.	
Unit –IV	**08 Hrs**
Linear Regression: Problem Formulation, Parameter Estimation, Bayesian Linear Regression, Maximum Likelihood as Orthogonal Projection. **Density Estimation with Gaussian Mixture Models:** Gaussian Mixture Model, Parameter Learning via Maximum Likelihood, EM Algorithm, Latent-Variable Perspective.	
Unit –V	**09 Hrs**
Dimensionality Reduction with Principal Component Analysis (PCA): Problem Setting, Maximum Variance Perspective, Projection Perspective, Eigenvector Computation and Low-Rank Approximations, PCA in High Dimensions, Key Steps of PCA in Practice, Latent Variable Perspective. **Classification with Support Vector Machines:** Separating Hyperplanes, Primal Support Vector Machine, Dual Support Vector Machine, Kernels, Numerical Solution.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore the fundamental concepts of mathematics involved in machine learning techniques.
CO2:	Orient the basic concepts of mathematics towards machine learning approach.
CO3:	Apply the linear algebra and probability concepts to understand the development of different machine learning techniques.
CO4:	Analyze the mathematics concepts to develop different machine learning models to solve practical problems.

Reference Books	
1	Mathematics for Machine Learning, M. P. Deisenroth, A. A. Faisal and C. S. Ong, 1st Edition, 2020, Cambridge University Press.
2	Linear Algebra and Learning from Data, Gilbert Strang, 1st Edition, 2019, Wellesley Cambridge Press, ISBN: 0692196382, 9780692196380.
3	Introduction to Machine Learning, Ethem Alpaydin, 2nd Edition, 2010, PHI Publication, ISBN-978-81-203-4160-9.
4	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, 2nd Edition, 2009, Springer, ISBN: 978-0-387-84857-0, 978-0-387-84858-7.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

V Semester						
ENGINEERING ECONOMY (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	:	**18G5B18**		**CIE**	:	**100 Marks**
Course Code	:	**18G5B02**		**SEE**	:	**100 Marks**
Total Hours	:	**39L**		**SEE Duration**	:	**03 Hours**

Course Learning Objectives: Students are expected to

1.	To inculcate an understanding of concept of money and its importance in the evaluation of projects.
2.	Analyze the present worth of an asset.
3.	Evaluate the alternatives based on the Equivalent Annual Worth.
4.	Illustrate concept of money and its importance in evaluating the projects.

Unit – I	**07 Hrs**
Introduction: Principles of Engineering Economy, Engineering Decision- Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Interest and Interest Factors: Interest rate, Simple interest, Compound interest, Cash- flow diagrams, Exercises and Discussion.	
Unit – II	**07 Hrs**
Present worth comparison : Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future worth comparison, Pay – back comparison, Exercises, Discussions and problems.	
Unit – III	**07 Hrs**
Equivalent annual worth comparisons: Equivalent Annual Worth Comparison methods, Situations for Equivalent Annual Worth Comparison Consideration of asset life, Comparison of assets with equal and unequal lives, Use of sinking fund method, Exercises, Problems. Rate of return calculations: Rate of return, Minimum acceptable rate of return, IRR, IRR misconceptions, Problems.	
Unit – IV	**06 Hrs**
Replacement Analysis: Replacement studies, replacement due to deterioration, obsolescence, inadequacy, economic life for cyclic replacements, Exercises, Problems. Break- Even Analysis: Basic concepts, Linear Break- Even analysis, Exercises, Problems.	
Unit – V	**06 Hrs**
Depreciation: Causes of Depreciation, Basic methods of computing depreciation charges, Exercises, Problems. Effects of inflation: Causes, consequences and control of inflation, inflation in economic analysis.	

Course Outcomes: After going through this course the student will be able to	
CO 1:	Explain the time value of money, and how to sketch the cash flow diagram
CO 2:	Compare the alternatives using different compound interest factors, Select a feasible alternative based on the analysis.
CO 3:	Formulate a given problem for decision making

CO 4:	Evaluate alternatives and develop capital budget for different scenarios

Reference Books:	
1.	Engineering Economy, Riggs J.L., 5th Edition, Tata McGraw Hill, ISBN 0-07-058670-5
2.	Engineering Economics, R Panneerselvam, Eastern Economy Edition 2001, PHI, ISBN – 81-203-1743-2.
3.	Cost Accounting, Khan M Y, 2nd Edition, 2000, Tata McGraw-Hill, ISBN 0070402248
4.	Mechanical Estimating & Costing, T.R.Banga, S.C.Sharma, 16th Edition, 2011, Khanna Publishers, ISBN 8174091009

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20. **Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	1	-	-	-	-	-	-	-	-	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-
CO3	1	1	1	-	1	-	-	-	-	-	-	-
CO4	-	1	2	-	1	1	-	-	-	-	1	-

High-3: Medium-2: Low-1

VI Semester						
INTRODUCTION TO MANAGEMENT & ECONOMICS (THEORY)						
Course Code	**:**	**18HEM61**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**03 Hrs**

Course Learning Objectives: The students will be able to

1	Understand the evolution of management thought.
2	Acquire knowledge of the functions of Management.
3	Gain basic knowledge of essentials of Micro economics and Macroeconomics.
4	Understand the concepts of macroeconomics relevant to different organizational contexts.

Unit-I	**07 Hrs**
Introduction to Management: Management Functions, Roles & Skills, Management History – Classical Approach: Scientific Management & Administrative Theory, Quantitative Approach: Operations Research, Behavioral Approach: Hawthorne Studies, Contemporary Approach: Systems & Contingency Theory.Case studies	
Unit – II	**09 Hrs**
Foundations of Planning: Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate & Competitive Strategies. **Case studies** **Organizational Structure & Design:** Overview of Designing Organizational Structure: Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures.**Case studies**	
Unit –III	**09 Hrs**
Motivating Employees: Early Theories of Motivation: Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Theory Y, Herzberg's Two Factor Theory, Contemporary Theories of Motivation: Adam's Equity & Vroom's Expectancy Theory.**Case studies** **Managers as Leaders:** Behavioral Theories: Ohio State & University of Michigan Studies, Blake & Mouton's Managerial Grid, Contingency Theories of Leadership: Hersey & Blanchard's Situational Leadership, Contemporary Views of Leadership: Transactional & Transformational Leadership. **Case studies**	
Unit –IV	**07 Hrs**
Introduction to Economics: Importance of Economics,Microeconomics and Macroeconomics,Theories and Models to Understand Economic Issues,An Overview of Economic Systems.Demand, Supply, and Equilibrium in Markets for Goods and Services,Price Elasticity of Demand and Price Elasticity of Supply,Elasticity and Pricing,Changes in Income and Prices Affecting Consumption Choices,MonopolisticCompetition,Oligopoly.	
Unit –V	**07Hrs**
Essentials of Macroeconomics: Prices and inflation,Exchangerate,Gross domestic product(GDP) ,components of GDP,theLaborMarket,Money and banks,Interestrate,Macroeconomic models- an overview,Growth theory, The classical model, Keynesian cross model, IS-LM-model, The AS-AD-model, The complete Keynesian model, The neo-classical synthesis, Exchange rate determination and the Mundell-Fleming model	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the principles of management theory & recognize the characteristics of an organization.
CO2:	Demonstrate the importance of key performance areas in strategic management and design appropriate organizational structures and possess an ability to conceive various organizational dynamics.
CO3:	Select & Implement the right leadership practices in organizations that would enable systems orientation.
CO4:	Understand the basic concepts and principles of Micro economics and Macroeconomics.

Reference Books	
1	Stephen Robbins, Mary Coulter &NeharikaVohra, Management, Pearson Education Publications, 10th Edition, ISBN: 978-81-317-2720-1.
2	James Stoner, Edward Freeman & Daniel Gilbert Jr, Management, PHI, 6th Edition, ISBN: 81-203-0981-2.
3	Steven A. Greenlaw ,David Shapiro,Principles of Microeconomics,2nd Edition,ISBN:978-1-947172-34-0
4	Dwivedi.D.N, Macroeconomics: Theory and Policy,McGraw Hill Education; 3rd Edition,2010,ISBN-13: 978-0070091450.
5	Peter Jochumzen, Essentials of Macroeconomics, e-book(www.bookboon.com), 1st Edition., 2010, ISBN:978-87-7681-558-5.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

50% weightage should be given to case studies. Total CIE is 30(Q) + 50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level. **50% weightage should be given to case studies.**

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**---**	**1**	**---**	**----**	**3**	**----**	**3**	**3**	**3**	**3**	**3**
CO2	**3**	**2**		**---**	**---**	**---**	**----**	**1**	**2**	**3**	**2**	**2**
CO3	**---**	**---**	**1**	**---**	**---**	**2**	**---**	**2**	**2**	**3**	**3**	**3**
CO4	**2**	**---**	**2**	**---**	**----**	**3**	**1**	**3**	**2**	**2**	**3**	**3**

High-3 : Medium-2 : Low-1

Semester: VI						
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (Theory & Practice) (Common to CS & IS)						
Course Code	:	**18CS62**		**CIE Marks**	**:**	**100+50**
Credits: L:T:P	:	**3 : 1 :1**		**SEE Marks**	**:**	**100+50**
Total Hours	:	**39L+26T +35P**		**SEE Duration**	**:**	**3 Hrs + 3 Hrs**

Course Learning Objectives: The students will be able to	
1.	Acquire basic principles of working of Artificial Intelligence technology and Machine learning algorithms
2.	Understand the practical requirements of AI agents, Searching strategies, Propositional and First-order Logics
3.	Develop AI and ML solutions for reasoning while dealing the uncertain situations, and making use of effective Knowledge representation strategies
4.	Identify the applications of some of the Machine learning techniques such as Bayesian networks, Decision tress, and Reinforcement learning in real world problems

Unit – I	**7 Hrs**
Introduction, intelligent agents, searching: What is AI? Intelligent Agents: Agents and environment; Rationality; the nature of environments; the structure of agents. Problem-solving: Problem-solving agents; Searching for solution; Uninformed search strategies; Informed search strategies, Heuristic Functions	
Unit – II	**8 Hrs**
Adversarial search, constraint satisfaction problems, logical agents, first-order logic : Games, Optimal decision in games, Alpha-Beta Pruning, Defining Constraint satisfaction problems; Backtracking search for CSPs; Knowledge-based agents; The Wumpus world as an example world; Logic; propositional logic; Propositional theorem proving; Syntax and semantics of first-order logic; Using first-order logic;	
Unit – III	**8 Hrs**
Knowledge representation: Ontological Engineering; Categories and Objects; Events; Mental events and Mental objects; Reasoning system for categories; **Probabilistic reasoning:** Representing knowledge in an uncertain domain; Semantics of Bayesian Networks; Efficient representation of conditional distributions; Exact inference in Bayesian Networks; Approximate inference in Bayesian Networks;	
Unit – IV	**8 Hrs**
Introduction to machine learning: Well-posed learning algorithms; Designing a learning algorithm; Perspectives and Issues in machine learning; **Decision tree learning:** Introduction, Decision tree representation; Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning;	
Unit – V	**8 Hrs**
Instance based learning: Introduction; k-nearest neighbor learning; Locally weighted regression; Radial based regression case-based functions; **Reinforcement learning:** Introduction; The learning task; Q learning; Nondeterministic rewards and actions;	

Laboratory Component

Open ended AI/Machine Learning based experiential project should be carried out in a team of two students, belongs to same batch of the laboratory of that particular section. (Cross-sections and Cross-batches not allowed)

General Guidelines for the project

The topic of the project should be from current thrust areas along with consultation with the faculty in charge.

There may be more than one batch solving same problem, but you need to have different approaches and the best approach will be ranked high.

The selected topic on the basis of standard papers (like IEEE/ACM/CSI etc.) is highly encouraged.

Presenting/publishing the paper in a reputed IEEE/ACM conferences / Journal with good indexing like WoS, SCI, Scopus, will attract higher marks in CIE.

The student needs to submit both hard & soft copy of the report for valuation.

All the batches must adhere to the guidelines released time to time by the Lab coordinators, and submit all the proofs asked in support of your experiential project.

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Describe the required theory and building blocks of Artificial intelligence technology and Machine learning algorithms
CO 2:	Demonstrate the working of various searching algorithms, games, pruning, inferencing, etc. with suitable examples.
CO 3:	Choose the suitable AI and machine learning technique for a given use case and analyze it's performance while solving real world problems.
CO 4:	Recommend and develop the AI and ML-based solutions for some of the well-posed learning problems.

Reference Books:	
1.	**AI – A Modern Approach, Stuart Russel, Peter Norvig, 3rd Edition, 2010, Pearson, ISBN-13: 978-0136042594**
2.	**Machine Learning, Tom M. Mitchell, Publisher: McGraw-Hill Science/Engineering/Math; (March 1, 1997) ,ISBN: 0070428077**
3.	Introduction to Machine Learning, Ethem Alpaydin, 2nd Edition, 2010, PHI Publication, ISBN-978-81-203-4160-9.
4.	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, and Jerome 2008Friedman: Springer, ISBN 978-0-387-84858-7.
5.	Pattern Classification, Richard O. Duda, Peter E. Hart and David G. Stork, 2nd Edition, 2001, Wiley-Inter science, ISBN-13: 978-04710566902001.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**--**	**--**	**2**	**2**	**2**	**--**	**2**	**2**	**--**	**3**
CO2	**2**	**2**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO4	**1**	**2**	**--**	**3**	**2**	**2**	**--**	**--**	**2**	**--**	**--**	**2**

High-3: Medium-2: Low-1

Semester: VI						
COMPILER DESIGN (Theory & Practice)						
Course Code	**:**	**18CS63**		**CIE Marks**	**:**	**100+50**
Credits: L:T:P	:	**3:0:1**		**SEE Marks**	**:**	**100+50**
Total Hours	:	**39L + 35P**		**SEE Duration**	**:**	**3 Hrs + 3 Hrs**

Course Learning Objectives: The students will be able to

1.	Learn basic skill for constructing the compiler which gives the good insight into the algorithms, which have wider applications.
2.	Gain Knowledge of different forms of language translators that shapes compilers.
3.	Construct lexical analyser and the parsing methods that are typically used in compilers
4.	Know about the principle ideas in syntax directed definitions and translations to generate intermediate code for the typical programming languages.
5.	Understand about the Syntax directed translation, code generation and code optimization.

Unit – I	**7Hrs**
Introduction to Compiling and Lexical Analysis Introduction, Language Processors, The structure of Compiler, Evolution of programming Languages. Lexical Analysis- The Role of Lexical Analyzer, Input Buffering, Specifications of Tokens, Recognition of Tokens.	
Unit – II	**9Hrs**
Syntax Analysis Introduction, Context-free Grammars, Writing a Grammar, Top-down Parsing, Bottom-up Parsing, Introduction to LR Parsing: Simple LR, Most powerful LR parsers (Excluding efficient construction and compaction of parsing tables), Using ambiguous grammars.	
Unit – III	**9 Hrs**
Lexical –Analyzer and Parser generators Lexical –Analyzer generator Lex, The parser generator YACC, Using YACC with ambiguous grammars, Creating YACC lexical Analyzer with LEX, Error recovery in YACC **Syntax-Directed Translation** Syntax-Directed Definitions, Evaluation orders for SDD, Application of Syntax Directed Translation.	
Unit – IV	**7Hrs**
Intermediate Code Generation Variants of Syntax trees, Three address code, Types and Declaration-Type Expressions, equivalence, Declaration, Control flow, Back patching.	
Unit – V	**7 Hrs**
Code Generation and optimization Issues in the design of Code Generator, The Target Language, Address in the target Code, Basic Blocks and Flow graphs, Optimization of Basic blocks, A Simple Code Generator, Peephole Optimization. Introduction to LLVM compiler and Clang.	

Laboratory Component
Student should be able to design phases of compiler by incorporating following features: 1 Writing a scanner, writing predictive parser for a language constructs. 2 Experiment with scanner (lex/flex) and parser (yacc/byson) generators 3 Writing scanner-parse specification for a simple language constructs. 4 Translation of the language constructs to an intermediate form (e.g. three-address code), 5 Generation of target code (in assembly language) using compiler construction tools. 6 Code improvement and optimization using LLVM compiler.

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand and explore the fundamental concepts of compiler design and its implementation.
CO 2:	Identify and apply rules for designing various phases of compiler
CO 3:	Analyse the practices adopted in constructing an efficient compiler.
CO 4:	Implement and demonstrate in-depth knowledge of various technologies related to principles, techniques and tools for designing compiler.

Reference Books:	
1.	Compilers- Principles, Techniques and Tools, Alfred V Aho, Monica S.Lam, Ravi Sethi, Jeffrey D Ullman; 2nd Edition, 2013, Pearson Education, ISBN – 10-1-292-02434-8, ISBN – 13- 978-1-292-02434-9.
2.	Compiler Design, Santanu Chattopadhyay, 1st Edition, 2011, PHI Learning, ISBN-978-81-203-2725-2.
3.	Compiler Construction Principles & Practice, Kenneth C Louden; Cengage Learning, 1st Edition, 2009. ISBN – 0534939724.
4.	Crafting a Compiler with C, Charles N. Fischer, Richard J. leBlanc, Jr., 1st Edition, 2009, Pearson Education, ISBN-13:978-0136067054, ISBN-10: 0136067050.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub

questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**1**
CO2	**1**	**2**	**-**	**1**	**2**	**-**	**1**	**-**	**1**	**2**	**-**	**1**
CO3	**2**	**1**	**2**	**-**	**2**	**-**	**1**	**-**	**2**	**3**	**-**	**1**
CO4	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**3**	**3**	**-**	**1**

High-3: Medium-2: Low-1

Semester: VI						
Minor Project						
Course Code	**:**	**18CS64**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Hours	**:**	**26P**		**SEE Duration**	**:**	**02 Hours**
Course Learning Objectives: To enable the students to:						
1	***Knowledge Application:***Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.					
2	***Communication:***Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both the written and oral forms.					
3	***Collaboration:***Acquire collaborative skills through working in a team to achieve common goals.					
4	***Independent Learning:***Learn on their own, reflect on their learning and take appropriate action to improve it.					

Guidelines for Minor Project

1. The minor project is to be carried out individually or by a team of two-three students.
2. Each student in a team must contribute equally in the tasks mentioned below.
3. Each group has to select a current topic that will use the technical knowledge of their program of study after intensive literature survey.
4. The project should result in system/module which can be demonstrated, using the available resources in the college.
5. The CIE evaluation will be done by the committee constituted by the department. The committee shall consist of respective guide & two senior faculty members as examiners. The evaluation will be done for each student separately.
6. The final copy of the report should be submitted after incorporation of any modifications suggested by the evaluation committee.

The minor-project tasks would involve:

1. Carry out the Literature Survey of the topic chosen.
2. Understand the requirements specification of the minor-project.
3. Detail the design concepts as applicable through appropriate functional block diagrams.
4. Commence implementation of the methodology after approval by the faculty.
5. Conduct thorough testing of all the modules developed and carry out integrated testing.
6. Demonstrate the functioning of the minor project along with presentations of the same.
7. Prepare a project report covering all the above phases with proper inference to the results obtained.
8. Conclusion and Future Enhancements must also be included in the report.

The students are required to submit the report in the prescribed format provided by the department.

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Interpreting and implementing the project in the chosen domain by applying the concepts learnt.
CO 2:	The course will facilitate effective participation by the student in team work and development of communication and presentation skills essential for being part of any of the domains in his / her future career.
CO 3:	Appling project life cycle effectively to develop an efficient product.
CO 4:	Produce students who would be equipped to pursue higher studies in a specialized area or carry out research work in an industrial environment.

Scheme of Evaluation for CIE Marks:

Evaluation will be carried out in three phases:

Phase	**Activity**	**Weightage**
I	Synopsis submission, approval of the selected topic, Problem definition, Literature review, formulation of objectives, methodology	10M
II	Mid-term evaluation to review the progress of implementation, design, testing and result analysis along with documentation	15M
III	Submission of report, Final presentation and demonstration	25M
	Total	**50M**

Scheme of Evaluation for SEE Marks:

Sl. No.	**Evaluation Component**	**Marks**
1.	Written presentation of synopsis: Write up	5M
2.	Presentation/Demonstration of the project	15M
3.	Demonstration of the project	20M
4.	Viva	05M
5.	Report	05M
	Total	**50M**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO4	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**1**

High-3: Medium-2: Low-1

Semester: VI						
INTERNET OF THINGS **(Group C: Professional Elective)** **(Common to All Branches)**						
Course Code	**:**	**18CS6C1**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to

1.	Understand design principles in Iot ,edge ,fog computing and its challenges
2.	Identify the Internet Connectivity, security issues and its protocols
3.	Explore and implement Internet of Things (IoT) and New Computing Paradigms
4.	Apply and analyze the Orchestration and resource management inioT, 5G, Fog, Edge, and Clouds

Unit – I	**8 Hrs**
Internet of Things Strategic Research and Innovation Agenda -Internet of Things Vision ,IoT Strategic Research and Innovation Directions , IoT Applications , Internet of Things and Related Future Internet Technologies , Infrastructure , Networks and Communication , Processes , Data Management , Security, Privacy & Trust , Device Level Energy Issues	
Unit – II	**8 Hrs**
Internet of Things Standardisation — Status, Requirements, Initiatives and Organisations - Introduction , M2M Service Layer Standardisation , OGC Sensor Web for IoT , IEEE and IETF , ITU-T . Simpler IoT Word(s) of Tomorrow, More Interoperability Challenges to Cope Today-Physical vs Virtual , Solve the Basic First — The Physical Word , The Data Interoperability , The Semantic Interoperability , The Organizational Interoperability , The Eternal Interoperability , The Importance of Standardisation — The Beginning of Everything	
Unit – III	**8 Hrs**
Internet of Things Privacy, Security and Governance-Introduction, Overview of Activity Chain — Governance, Privacy and Security Issues, Contribution From FP7 Project, Security and Privacy Challenge in Data Aggregation for the IoT in Smart Cities-Security, Privacy and Trust in Iot-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach	
Unit – IV	**8 Hrs**
Internet of Things (IoT) and New Computing Paradigms Fog and Edge Computing Completing the Cloud ,Advantages of FEC: SCALE , How FEC AchievesThese Advantages: SCANC 9,Hierarchy of Fog and Edge Computing , Business Models , **Addressing the Challenges in Federating Edge Resources,** The Networking Challenge, The Management Challenge , **Integrating IoT + Fog + Cloud**	
Unit – V	**7 Hrs**
Management and Orchestration of Network Slices in 5G, Fog, Edge, and Clouds Introduction ,Background, Network Slicing in 5G, Network Slicing in Software-Defined Clouds, Network Slicing Management in Edge and Fog	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand and Explore Internet of Things (IoT) with New Computing Paradigms like 5G, Fog, Edge, and Clouds
CO 2:	Analyze Prototyping and demonstrate resource management concepts in New Computing Paradigms
CO 3:	Apply optimal wireless technology to implement Internet of Things and edge computing applications
CO 4:	Propose IoT-enabled applications for building smart spaces and services with security features, resource management and edge computing

Reference Books:	
1.	Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers, 2013ISBN: 978-87-92982-73-5(Print) ISBN: 978-87-92982-96-4(E-Book).
2.	Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya , Satish Narayana Srirama, 2019, Wiley series on parallel and distributed computing, ISBN: 978-1-119-52498-4.
3.	Internet of Things: Architecture and Design Principles, Raj Kamal, 2017, TMH Publications, ISBN:9789352605224.
4.	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, 1st Edition, 2013, Willy Publications ,ISBN: 978-1-118-47347-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**1**	**1**	**-**	**2**	**2**	**-**	**-**	**1**	**-**	**2**
CO2	**2**	**2**	**1**	**1**	**-**	**2**	**2**	**-**	**1**	**1**	**-**	**3**
CO3	**1**	**2**	**1**	**1**	**-**	**2**	**2**	**-**	**1**	**1**	**-**	**2**
CO4	**1**	**2**	**2**	**2**	**-**	**3**	**3**	**1**	**2**	**2**	**-**	**3**

High-3: Medium-2: Low-1

Semester: VI						
ADVANCED ALGORITHMS (Group C: Professional Elective) (Common to CS & IS)						
Course Code	**:**	**18IS6C2**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to

1.	Enhance their knowledge on asymptotic performance of various algorithms.
2.	Develop the skills to design and apply efficient algorithms tovarious real world problems.
3.	Ability to differentiate between various design paradigms and apply the same appropriately
4.	Appreciate the time and space complexity of various algorithms

Unit-I	**08Hrs**
Analysis techniques: Growth of functions: Asymptotic notation, Standard notations and common functions, Substitution method for solving recurrences, Recursion tree method for solving recurrences, Master theorem. **Amortized Analysis :**Aggregate analysis, The accounting method, The potential method.	
Unit – II	**08 Hrs**
Sorting in Linear Time: Lower bounds for sorting, Counting sort, Radix sort, Bucket sort. **Advanced Design and Analysis Technique:** Matrix-chain multiplication, Longest common subsequence, Elements of the greedy strategy,An activity-selection problem	
Unit –III	**08 Hrs**
Graph Algorithms Bellman-Ford Algorithm, Shortest paths in a DAG, Johnson's Algorithm for sparse graphs. **Maximum Flow** Flow networks, Ford Fulkerson method and Maximum Bipartite Matching	
Unit –IV	**07Hrs**
Number Theoretic Algorithms: Elementary notions, GCD, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element, RSA cryptosystem.	
Unit –V	**08 Hrs**
Advanced Data structures: Structure of Fibonacci heaps, Mergeable-heap operations, Decreasing a key and deleting a node, Binomial Queues, Splay Trees. **String Matching Algorithms:** Naïve algorithm, Rabin-Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Analyze various algorithms for their time and space complexity.
CO2:	Demonstrate a familiarity with major algorithms and data structures
CO3:	Apply appropriate design techniques for solving real world problems.
CO4:	Design and implement solutions using appropriate mathematical techniques.

Reference Books	
1	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein; Introduction to Algorithms; Columbia University, 3rdEdition; 2009, ISBN-13: 978-0262033848.
2	Mark Allen Weiss; Data Structures and Algorithm Analysis in C++, Addison-Wesley; 4thRevised edition; 2013, ISBN-13: 9780132847377.
3	Kozen DC, The design and analysis of algorithms , Springer Science & Business Media, 2012, ISBN: 978-0387976877
4	Kenneth A. Berman, Jerome L. Paul,Algorithms, Cengage Learning, 2002. ISBN: 978-8131505212

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**2**	**2**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**1**	**3**	**2**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
CO3	**1**	**3**	**2**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
CO4	**1**	**3**	**2**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**

High-3: Medium-2: Low-1

Semester: VI						
FUZZY LOGIC **(Group C: Professional Elective)** **(Common to CS & IS)**						
Course Code	**:**	**18CS6C3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to	
1	Gain knowledge of fundamental concepts in Fuzzy Logic.
2	Illustrate fuzzy sets and fuzzy logic as mathematical models.
3	Focus on problems related to various engineering, mathematics and science disciplines.
4	Use fuzzy logic based techniques for various applications.

Unit – I	**07Hrs**
Introduction The case for Imprecision, The Utility and Limitations of Fuzzy Systems, Fuzzy sets and membership, Chance verses fuzziness, Sets as points in hyper cubes. Fuzzy Sets - Fuzzy set operations, Properties of Fuzzy Sets, Alternative fuzzy set operations, Membership value Assignments, Intuition, Inference, Features of the Membership Function **Fuzzy Relations** Fuzzy Relations, Cardinality of Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Cartesian product and Composition, Fuzzy Tolerance and equivalence Relations. Value Assignments - Cosine Amplitude, Max-min Method	
Unit – II	**08Hrs**
Fuzzification and Defuzzification Fuzzification,defuzzification to crisp sets, Lambda-cuts for fuzzy relations, Defuzzification to Scalars **Fuzzy Logic and Fuzzy Systems** Classical Logic – Tautologies, Contradictions, Equivalence, Exclusive or and Exclusive Nor, Logical Proofs, Deductive Inferences. Fuzzy Logic, approximate reasoning, other forms of the Implication Operation, Fuzzy Systems: Natural Languages, Fuzzy (Rule -Based) systems.	
Unit – III	**08Hrs**
Fuzzy Arithmetic and Extension Principle Extension principle, Crisp Function, Mapping and Relations, Function of fuzzy sets- Extension principle, fuzzy transform, practical considerations, fuzzy arithmetic, internal analysis in arithmetic, Approximate of extension. **Fuzzy Soft Sets** Soft Sets and Fuzzy Soft Sets – Soft sets and Fuzzy Soft set operations, Properties of soft sets and Fuzzy Soft Sets, Cartesian product of soft sets and fuzzy soft sets, Fuzzy Soft set Relations, Operations on Fuzzy Soft Set Relations, Composition of fuzzy Soft Set relation.	
Unit – IV	**8Hrs**
Fuzzy Classification and Pattern Recognition Classification of Equivalence relations, Crisp Relations and Fuzzy Relations, Cluster Analysis, Cluster Validity, c-means clustering, Hard c-means, Fuzzy c-means algorithm, cluster validity,Knowledge based pattern recognition, Hybrid pattern based recognition, applications in Medical Image Segmentation: case study of hybrid fuzzy system for MRI segmentation.	
Unit – V	**8Hrs**
Fuzzy Logic and Artificial Intelligence	

AI, Neural Network, genetic Algorithms, Fuzzy logic in frame based representation, FL in expert systems, Intelligent Agents, FL in Intelligent systems. **Fuzzy Logic in Database and Information Systems** Fuzzy information, FL in database systems, fuzzy relation data models and its operations,

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Explore and Understand basic concepts of all types of fuzzy sets and relations, fuzzy logic extension principle in the field of computer science and Engineering.
CO 2:	Analyse the tools of all types of fuzzy sets in different areas of intelligent information systems where uncertainty and imprecision are involved.
CO 3:	Design fuzzy systems and solve complex problems using various fuzzy techniques.
CO 4:	Create application by utilizing cloud platforms. Apply fuzzy systems and solve complex problems using various fuzzy techniques.

Reference Books	
1.	Fuzzy logic with engineering applications, Timothy J. Ross, John Wiley, 2nd Edition, 2007, ISBN: 13 978-81-265-1337-6.
2.	Fuzzy Logic Intelligence, Control and Information, John Yen, Reza Langari, 1st edition, 9th Impression, 2012, Pearson, ISBN: 978-81-317-0534-6.
3.	Fuzzy Sets and Fuzzy Logic-Theory and Applications, George J. Klir, Bo Yuan, Prentice Hall, 1st Edition; 2008, ISBN: 81-203-0695-3.
4.	Fuzzy Logic Theory and Applications: Part I and Part II, Lofti A Zadeh and Rafik A Aliev, World Scientific Publishing Co. PTe. Ltd, 2018, ISBN: 978-9813238176
5.	Fuzzy Sets and Fuzzy Logic with Applications: Implementation, Uncertainty and Vagueness, M.K. Hasan, 2019, Scholars Press, ISBN-978-6138833789
6.	Research Papers on Soft sets and Fuzzy Soft sets.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**-**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**2**
CO2	**1**	**3**	**-**	**2**	**2**	**1**	**-**	**1**	**1**	**2**	**2**	**2**
CO3	**2**	**1**	**-**	**1**	**1**	**1**	**-**	**1**	**1**	**2**	**1**	**2**
CO4	**2**	**2**	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**2**	**-**	**2**

High-3 : Medium-2 : Low-1

Semester: VI						
DATA WAREHOUSING AND DATA MINING (Group C: Professional Elective)						
Course Code	:	**18CS6C4**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to

1.	To understand the concepts of data warehousing and data mining.
2.	To learn different classification techniques adopted for data mining.
3.	To learn the visualization techniques in data mining

Unit – I	**8 Hrs**

Data Warehouse : Introduction to Data Warehouse, Differences between Operational Database Systems and Data Warehouses , A Separate Data Warehouse, Data Warehousing : A Multitier Architecture, Data Warehouse Models: Enterprise Warehouse, Data Mart, and Virtual Warehouse, Extraction, Transformation, and Loading, Metadata Repository

Data Warehouse Modelling: Data Cube and OLAP; Data Cube : A Multidimensional Data Model, Stars, Snowflakes, and Fact Constellations: Schemas for multidimensional Data Models, Dimensions: The Role of Concept Hierarchies, Typical OLAP Operations,A Starnet Query Model for Querying Multidimensional Databases.

Unit – II	**8 Hrs**

Introduction to Data Mining: Kinds of data,kinds of patterns,technologies used,Applications,Major Issues in Data Mining.

Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Preprocessing: An Overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization

Unit – III	**8 Hrs**

Mining Frequent Patterns, Associations, and Correlations: Basic Concepts, Frequent Itemset Mining Methods, Pattern Evaluation Methods

Basic concepts of classification: Decision Tree Induction, Bayesian Classification, Rule based Classification, Model Evaluation and selection, Techniques to improve classification accuracy

Unit – IV	**8 Hrs**

Classification: Advanced Methods: Bayesian Belief Networks, Classification by Back propagation, Support Vector Machines, Classification Using Frequent Patterns

Unit – V	**7 Hrs**

Cluster Analysis: Basic Concepts and Methods: Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand the concepts of data warehousing and data mining.
CO 2:	To apply the classification and clustering algorithms for the historical data.
CO 3:	To identify hidden patterns in the huge data.
CO 4:	To visualize and draw inference from the knowledge extracted for decision making.

Reference Books:	
1.	Data Mining – Concepts and Techniques, Jiawei Han and Micheline Kamber, 3rd Edition, 2012, Morgan Kaufmann, ISBN 978-0-12-381479-1.
2.	Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Vipin Kumar, 2007, Pearson Education, ISBN 9788131714720
3.	Practical data science with R, Zumel, N. & Mount, J, 2014, Manning Publications, ISBN 9781617291562
4.	Introduction to Machine Learning, Ethem Alpaydin, 2nd Edition, 2010, PHI Publication, ISBN-978-81-203-4160-9.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**--**	**1**	**2**	**2**	**2**	**1**	**2**	**2**	**--**	**3**
CO2	**2**	**2**	**2**	**1**	**2**	**--**	**--**	**1**	**--**	**1**	**--**	**2**
CO3	**1**	**--**	**2**	**1**	**1**	**--**	**--**	**1**	**--**	**1**	**--**	**2**
CO4	**1**	**2**	**--**	**2**	**2**	**2**	**--**	**1**	**2**	**1**	**--**	**2**

High-3: Medium-2: Low-1

Semester: VI						
BIG DATA ANALYTICS USING DISTRIBUTED PLATFORMS **(Group C: Professional Elective)** **(Common to CS & IS)** **(Industry Offered)**						
Course Code	**:**	**18CS6C5**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to

1.	Think and handle big data, and perform data analysis.
2.	Use HPCC platform and ECL programming language for big data processing.
3.	Understand and apply machine learning algorithms on distributed platform

Unit – I	**08Hrs**
Big data processing and Distributed architectures -Types of data: Structured, semi structured, unstructured **,** Data Pre-processing: Data cleaning, Data Integration, Data Reduction, Data Transformation and discretization, data cleaning, validation, modifications, enhancements. Distributed Architectures : Hadoop, spark, HPCC Systems Vs Hadoop	
Unit – II	**08Hrs**
HPCC Systems architecture HPCC System functions, Data Lake Architecture, The HPCC Systems design, Thor Vs ROXIE **ECL the programming language & Structures** ECL Watch, ECL Cloud IDE / VS Code, Simple ECL programs and Data Types explained, Data flow graphs (diagrams), Declarative programming, Declarative vs Imperative programming, the ECL Compiler, The ECL program deployment and execution	
Unit – III	**08Hrs**
ECL the programming language & Structures An Activity, An Activity Declaration, A Record Declaration, Schema on Read (RECORD) explained, A Function Declaration, A MODULE, ECL File(s), Importing files, Spraying and Reading a file **Data Shaping (Transforming)** FUNCTION, MODULE and PROJECT, ITERATE and ROLLUP ,SORT, JOIN and DEDUP ,NORMALIZE and DENORMALIZE ,DISTRIBUTE and Reading the execution Graph	
Unit – IV	**08Hrs**
Data Aggregation GROUP and functions (SUM, AVE, COUNT…), TABLE and AGGREGATE **HPCC Systems Machine Learning Library- Part I** ML_Core , PBblas- Parallel Block Linear Algebra Subsystem, Supervised Learning Bundles- Linear Regression, Logistic Regression, Support Vector Machines, Learning Trees	
Unit – V	**07Hrs**
HPCC Systems Machine Learning Library- Part II Supervised Learning Bundles- GLM, Generalized Neural Network, Unsupervised Learning Bundles- K-Means, DBSCAN, Natural Language Processing Bundles- TextVectors	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand and explore the concepts of data processing, distributed systems, HPCC systems, ECL programming language and HPCC machine learning library.
CO 2:	Apply ECL programming language & structures, Machine Learning Algorithms on HPCC Systems Platform
CO 3:	Analyse Machine Learning Algorithms on HPCC platforms
CO 4:	Implement Machine Learning Algorithms on HPCC Platform.

Reference Books:	
1.	Detailed handouts with references to material available on the web will be handed out every week. https://hpccsystems.com/training/documentation/learning-ecl https://github.com/hpcc-systems/Solutions-ECL-Training,
2.	Data Mining – Concepts and Techniques, Jiawei Han and Micheline Kamber, Jian Pei, 3rd Edition, 2012, Morgan Kaufmann, ISBN 978-0-12-381479-1.
3.	Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Vipin Kumar:, 2007, Pearson Education, ISBN 978-81-317-1472-0.
4.	Big Data and Analytics, Seema Acharya and Subhashini C, 1st Edition, 2015,Wiley India Private Limited, ISBN 978-8126554782.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**--**	**--**	**2**	**2**	**2**	**--**	**2**	**2**	**--**	**3**
CO2	**2**	**2**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO4	**1**	**2**	**--**	**3**	**2**	**2**	**--**	**--**	**2**	**--**	**--**	**2**

High-3: Medium-2: Low-1

Semester: VI						
WEB TECHNOLOGY **(Group D: Professional Elective)** **(Common to CS & IS)**						
Course Code	**:**	**18IS6D1**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to

1.	Understand the standard structure of HTML/XHTML and its differences.
2.	Adapt HTML and CSS syntax & semantics to build web pages.
3.	Learn the definitions and syntax of different web programming tools such as JavaScript, XML, Ajax, Angular JS and Node.js to design web pages.
4.	Design and develop interactive, client-side, server-side executable web applications using different techniques such as CSS, JavaScript, XML, Ajax, Angular JS and Node.js.

Unit-I	**08Hrs**
Introduction to Web, HTML and XHTML: Fundamentals of Web, XHTML: Basic syntax, Standard structure, Basic text markup, Images, Hypertext Links, Lists, Tables, Forms, Frames.HTML 5: The audio Element; The video Element; Organization Elements; The time Element, Syntactic Differences between HTML and XHTML. **CSS (Cascading Style Sheet):**Introduction, Levels of style sheets, Style specification formats, Selector forms, Property value forms, Font properties, List properties, Color, Alignment of text, The box model, Background images, The and tags, Conflict resolution.	
Unit – II	**08Hrs**
The Basics of JavaScript: Overview of JavaScript; Object orientation and JavaScript; General syntactic characteristics; Primitives, operations, and expressions; Screen output and keyboard input; Control statements. **JavaScript (continued):**Object creation and modification; Arrays; Functions; Constructor; Pattern matching using regular expressions; Errors in scripts.	
Unit –III	**08 Hrs**
JavaScript and HTML Documents: The JavaScript execution environment; The Document Object Model; Element access in JavaScript; Events and event handling; Handling events from the Body elements, Button elements, Text box and Password elements; The DOM 2 event model; The navigator object. **Dynamic Documents with JavaScript:** Introduction to dynamic documents; Positioning elements; Moving elements; Element visibility; Changing colors and fonts; Dynamic content; Stacking elements; Locating the mouse cursor; Reacting to a mouse click; Slow movement of elements; Dragging and dropping elements and Introduction to jQuery.	
Unit –IV	**08Hrs**
Introduction to PHP: Origins and uses of PHP; overview of PHP; General syntactic characteristics; Primitives, Operations and Expressions; Output; Control statements; Arrays; Functions; Pattern Matching; Form Handling;Cookies; Session Tracking. **XML:**Introduction; Syntax; Document structure; Document Type definitions; Namespaces; XML schemas; Displaying raw XML documents; Displaying XML documents with CSS; XSLT style sheets.	
Unit –V	**07 Hrs**
Ajax: Overview of Ajax; History of Ajax; Ajax Technology; Implementing Ajax, Basics of Ajax: The Application; The Form Document; The Request Phase; The Response Document; The Receiver Phase; Cross-Browser Support.	

Database Access through the web: Architectures for Database Access: Client Server Architecture; The Microsoft open Database Connectivity; PHP and Database Access; The Java JDBC Architecture; The MySQL Database System, Database Access with PHP and MySQL.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic syntax and semantics of HTML/XHTML.
CO2:	Apply HTML/XHTML tags for designing static web pages and forms using Cascading Style Sheet.
CO3:	Develop Client-Side Scripts using JavaScript and Server-Side Scripts using PHP and utilize the concepts of XML & Ajax to design dynamic web pages.
CO4:	Develop web based applications using PHP, XML and Ajax.

Reference Books	
1	Programming the World Wide Web – Robert W. Sebesta, 7th Edition, Pearson Education, 2013, ISBN-13:978-0132665810.
2	Web Programming Building Internet Applications – Chris Bates, 3rd Edition, Wiley India, 2006, ISBN: 978-81-265-1290-4.
3	Internet & World Wide Web How to H program – M. Deitel, P.J. Deitel, A. B. Goldberg, 3rd Edition, Pearson Education / PHI, 2004, ISBN-10: 0-130-89550-4
4	The Complete Reference to HTML and XHTML- Thomas A Powell, 4th Edition, Tata McGraw Hill, 2003, ISBN: 978-0-07-222942-4.
5	Programming the World Wide Web – Robert W. Sebesta, 7th Edition, Pearson Education, 2013, ISBN-13:978-0132665810.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**-**	**2**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**-**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
CO4	**-**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**

High-3: Medium-2: Low-1

Semester: VI						
QUANTUM COMPUTING (Group D: Professional Elective)						
Course Code	:	**18CS6D2**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to	
1.	Explain the basic concepts of quantum computation and its physics
2.	Use various operators of quantum computation and work on quantum transformation
3.	Illustrate the working of some standard quantum algorithms
4.	*Analyse the complexities involved in working of quantum algorithms*

Unit – I	**8 Hrs**
QUANTUM BUILDING BLOCKS: Quantum mechanics of Photon Polarization, Single Quantum bits, Single Qubit Measurement, A Quantum key Distribution Protocol, State Space of a Single-Qubit System, Direct Sums and Tensor Products of Vector Spaces, State Space of an n-Qubit System, Entangled States, Multi-Qubit Measurement, QKD using Entangled states	
Unit – II	**8 Hrs**
MULTIPLE-QUBIT STATES MEASUREMENTS: Dirac's bra/ket Notation for Linear transformations, Projection operators, Hermitian OperatorFormalism, Bell's Theorem	
Unit – III	**8 Hrs**
QUANTUM STATE TRANSFORMATIONS: Unitary transformations, Simple Quantum Gates, Pauli transformations, Hadamard Transformations, Multiple-Qubit Transformations, Controlled-NOT and other singly controlled gates, Applications of Simple Gates, Dense coding, Quantum teleportation	
Unit – IV	**8 Hrs**
QUANTUM ALGORITHMS: Computing with Superpositions, Walsh-Hadamard transformation, Quantum Parallelism, Notions of Complexity, Query Complexity, Communication Complexity, Simple Quantum Algorithm	
Unit – V	**7 Hrs**
SHOR'S AND GROVER'S ALGORITHM: Classical reduction to Period-Finding, Shor's factoring Algorithm, Example illustrating Shor's Algorithm, DLP and Hidden Subgroup Problems, Grover's Algorithm, Amplitude amplification	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Explain the various essentials of quantum computation, Qubits, and Quantum operators
CO 2:	Analyse working of quantum transformations and quantum gates
CO 3:	Describe principle of working of some of the standard quantum algorithms and their applications
CO 4:	Investigate the applications of quantum computing and quantum cryptography

Text Book:	
1.	Quantum Computing: A Gentle Introduction, Eleanor Rieffel and Wolfgang Polak, 2011, The MIT Press, ISBN 9780262015066.
Reference Books:	
1.	An introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, Muchele Mosca, Oxford University Press, 2007, ISBN-13: 978-0198570493, ISBN-10: 019857049X
2.	Quantum Computing for Computer Scientists, 1st Edition, Noson S. Yanofsky and Mirco A. Mannucci, Cambridge University Press, 2008, ISBN 978-0-521-879965.
3.	Quantum Computing for Everyone, Chris Bernhardt, MIT Press, 2019, ISBN: 9780262039253
4.	Mathematics of Quantum Computing: An Introduction, Wolfgang Scherer, Springer, 2019, ISBN-10: 303012357X.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**-**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**

High-3: Medium-2: Low-1

Semester: VI						
ARTIFICIAL NEURAL NETWORKS (Group D: Professional Elective)						
Course Code	**:**	**18CS6D3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3 :0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to	
1	Perceive the basic theory of ANN, applications and learning techniques
2	Explain the working of perceptron, adaptive filters, and unconstrained optimization techniques
3	Gain essential knowledge on back propagation algorithm with respect to multilayer perceptron, along with various related concepts
4	Explore the significance of support vector machines in ANN

UNIT-I	**08 Hrs**
ARTIFICIAL NEURAL NETWORKS INTRODUCTION AND LEARNING PROCESSES-I: What is a Neural Network? Human Brain, Models of a Neuron, Neural Networks Viewed as DG, Feedback, Network Architectures, Error-correction learning, Memory-based learning, Hebbian Learning, Competitive learning, Boltzmann Learning	
UNIT-II	**08 Hrs**
LEARNING PROCESSES– II& STATSTICAL LEARNING THEORY: Learning with a teacher, Learning without a teacher, Learning tasks (includes Function approximation, Control, Filtering) Memory, Adaptation. Statistical Learning Theory: Model of the supervised learning process, VC dimension with examples, Probably approximately correct model of learning	
UNIT-III	**08 Hrs**
SINGLE-LAYER PERCEPTRON: Adaptive filtering problem, Unconstrained optimization techniques: Steepest Descent, Newton's, Gauss-Newton; Linear Least-Squares Filter, Weiner Filter, LMS algorithm (includes Signal-Flow Graph Representations, Convergence Considerations), Learning curves, Learning rate annealing techniques, Perceptron and Convergence theorem	
UNIT-IV	**08 Hrs**
MULTILAYER PERCEPTRON: Back Propagation algorithm, Two passes of computation, Sequential and Batch Modes of training, Stopping Criteria, XOR problem, Heuristics for BP algorithm to perform better, Output representation and Decision rule, Generalization, Universal approximation theorem, Curse of Dimensionality, Cross-validation (includes Early stopping method of training and Variants)	
UNIT-V	**07 Hrs**
SUPPORT VECTOR MACHINES: Optimal hyperplane for linearly separable patterns, Optimal hyperplane for non-separable patterns, Building a support vector machine for pattern recognition, XOR Problem, SVM for nonlinear regression	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Describe basic concepts, theory of artificial neural network, applications and various learning models and techniques
CO 2:	Analyze and applyArtificialNeural Network Architectures, learning tasks, adaptive filters, and techniques for optimization
CO 3:	Explore modelling aspects of BP algorithm, SVM, Generalization, and Cross-validation
CO 4:	Investigate and apply neural networks model and learning techniques to solve problems related to society and industry, and demonstrate a prototype application developed using any NN tools and APIs

Text Books	
1.	Neural Networks – A Comprehensive Foundation, Simon Haykin, 2nd Edition, 2005, PHI. (Units I to III)
Reference Books	
1.	Introduction to Artificial Neural Networks, Gunjan Goswami, S.K. Kataria & Sons, 2012 Edition, ISBN-13: 978-9350142967.
2.	Neural Networks Design, M T Hagan, H B Demoth, M Beale, Thomson Learning, Edition, 2009, ISBN-13: 978-0-9717321-1-7.
3.	Fundamentals of Artificial Neural Networks, M H Hassoun, MIT Press, 2010, ISBN-13: 978-0262514675.
4.	Principles of Artificial Neural Networks: Basic Designs To Deep Learning, Graupe Daniel, 4th Edition, 2019, World Scientific.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**
CO2	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO3	**2**	**3**	**3**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**	**-**
CO4	**2**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**2**	**-**

High-3: Medium-2: Low-1

Semester: VI						
PROBABILITY, STATISTICS AND QUEUING THEORY (Group D: Professional Elective)						
Course Code	**:**	**18CS6D4**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3 :0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to
Understand the basics of Probability, Statistics and Queuing theory.
Evaluate probability bounds, basic statistical measures and demonstrate their significance.
Design and perform hypothesis tests and other evaluative tests.
Develop probability models for solving real world problems.

UNIT-I	**08Hrs**
Introduction of Probability and Random Variables: Axioms of probability, Conditional probability, Baye's theorem, Discrete Random variable and Continuous Random variable,pmf, pdf of some well-known distributions, Moment Generating Functions, Two-dimensional Random variables, Joint pmf and Joint pdf and their properties, Conditional distributions and conditional expectations, Covariance.	
UNIT-II	**09Hrs**
Probability bounds,Approximations,Testing Hypothesis and Regression: Probability inequalities - Markov's inequality, Chernoff bounds, Jensen's inequality, Chebyshev's inequality, Bienayme's inequality, Schwartz inequality, Cauchy-Schwartz inequality, sampling theory, Confidence intervals and Testing Hypothesis (Mean σ known and σ unknown, Standard deviation), Simple linear regression, Multiple linear regression,-assumptions, estimation of coefficients, coefficient of determination and adjusted coefficient of determination.	
UNIT-III	**08Hrs**
Random Processes: Classification, Methods of description, Special classes, Average values of Random Processes, Analytical representation of Random Process, Autocorrelation function, Cross-correlation function and their properties, Ergodicity, Poisson process, Counting processes, Inter-arrival and waiting time distributions, Markov Process, Markov chain.	
UNIT-IV	**07Hrs**
Queuing Theory: Symbolic Representation of a Queuing Model, Poisson Queue system, Little Law, Types of Stochastic Processes, Birth-Death Process, The M/M/1 Queue, M/M/m Queue, M/M/m/B Queue with Finite Buffers.	
UNIT-V	**07Hrs**
Random Number Generation: Desired Properties of a Good Generator, Linear-Congruential Generators, Tausworthe Generators, Extended Fibonacci Generators, Combined Generators, Testing Random Number Generators: Chi-Square Test, Kolmogorov-Smirnov.	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Identify basic tools of Probability and queuingin the fields where uncertainty and imprecision are involved.
CO2.	Apply random process, sampling theory, stochastic process and queuing models to the field of computer science.
CO3.	Apply probability models using modern tools of probability for synthesizing information to use effectively.
CO4.	Analyze and design probability models for various real world problems involving randomness.

Reference Books	
1.	Probability & Statistics with Reliability, Queuing and Computer Applications, Kishor S Trivedi, Eastern Economy Edition, 2nd Edition, 2008, Prentice Hall India, ISBN: 81-203-0508-6.

2.	Probability, Statistics and Random Processes, T Veerarajan, 3rd Edition, 2008, Tata McGraw Hill Education Private Limited, ISBN:978-0-07-066925-3.
3.	Probability and Statistics for Computer Scientists, Michael Baron, 3rd Edition, 2006, CRC Press, ISBN: 978-1138044487
4.	The Art of Computer Systems Performance Analysis, Raj Jain, 1st Edition, 2009, Wiley India Private Limited, ISBN:978-81265-1905-7.
5.	Probability and statistics for Engineers, Miller and Freund's, Richard .A. Johnson, C. B. Gupta, Second impression 2007, Pearson Education, ISBN: 978-0-12-051051-1.
6.	Introduction to Probability, Statistics and Random Processes, Kappa Research, Hossein Pishro-Nik, LLC, 2014, ISBN-978-0990637202

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**3**	**2**	**2**	**1**	**2**	**-**	**1**	**1**	**2**	**1**	**1**
CO2	**3**	**3**	**2**	**2**	**2**	**2**	**-**	**1**	**1**	**2**	**1**	**2**
CO3	**2**	**3**	**2**	**2**	**3**	**2**	**-**	**1**	**1**	**2**	**1**	**2**
CO4	**3**	**2**	**2**	**2**	**3**	**2**	**-**	**1**	**1**	**2**	**1**	**2**

High-3 : Medium-2 : Low-1

Semester: VI						
ROBOTIC PROCESS AUTOMATION DESIGN & DEVELOPMENT (Group D: Professional Elective) (Industry Offered)						
Course Code	:	**18CS6D5**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives: The students will be able to

1.	To understand Basic Programming concepts and the underlying logic/structure
2.	To Describe RPA , where it can be applied and how its implemented
3.	To Describe the different types of variables, Control Flow and data manipulation techniques
4.	To Describe automation to Email and various types of Exceptions and strategies to handle

Unit – I	**8 Hrs**
PROGRAMMING BASICS &RECAP: Programming Concepts Basics - Understanding the application - Basic Web Concepts - Protocols - Email Clients -. Data Structures - Data Tables - Algorithms - Software Processes - Software Design - Scripting - .Net Framework - .Net Fundamentals - XML - Control structures and functions - XML - HTML - CSS - Variables & Arguments.	
Unit – II	**8 Hrs**
RPA Concepts: RPA Basics - History of Automation - What is RPA - RPA vs Automation - Processes & Flowcharts - Programming Constructs in RPA - What Processes can be Automated - Types of Bots - Workloads which can be automated - RPA Advanced Concepts - 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.	
Unit – III	**8 Hrs**
RPA TOOL INTRODUCTION & BASICS: Introduction to RPA Tool - The User Interface - Variables - Managing Variables - Naming Best Practices - The Variables Panel - Generic Value Variables - Text Variables - True or False Variables - Number Variables - Array Variables - Date and Time Variables - Data Table Variables - Managing Arguments - Naming Best Practices - The Arguments Panel - Using Arguments - About Imported Namespaces - Importing New Namespaces- Control Flow - Control Flow Introduction - If Else Statements - Loops - Advanced Control Flow - Sequences - Flowcharts - About Control Flow - Control Flow Activities - The Assign Activity - The Delay Activity - The Do While Activity - The If Activity - The Switch Activity - The While Activity - The For Each Activity - The Break Activity - Data Manipulation - Data Manipulation Introduction - Scalar variables, collections and Tables - Text Manipulation - Data Manipulation - Gathering and Assembling Data	
Unit – IV	**8 Hrs**
ADVANCED AUTOMATION CONCEPTS AND TECHNIQUES : Recording and Advanced UI Interaction - Recording Introduction - Basic and Desktop Recording - Web Recording - Input/output Methods - Screen Scraping - Data Scraping - Scraping advanced techniques - Selectors - Selectors - Defining and Assessing Selectors - Customization - Debugging - Dynamic Selectors - Partial Selectors - RPA Challenge - Image, Text & Advanced Citrix Automation - 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 - Excel Data Tables & PDF - Data Tables in RPA - Excel and Data Table basics - Data Manipulation in excel - Extracting Data from PDF - Extracting a single piece of data - Anchors - Using anchors in PDF	

Unit – V	7 Hrs
EMAIL AUTOMATION & EXCEPTIONAL: Email Automation - Email Automation - Incoming Email automation - Sending Email , automation - Debugging and Exception Handling - Debugging Tools - Strategies for solving issues - Catching errors.	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand RPA principles, its features and applications.
CO 2:	Demonstrate proficiency in handling several types of variables inside a workflow and data manipulation techniques
CO 3:	Gain insights into Desktop, Web, Citrix, Email Automation and exception handling.
CO 4:	Analyze and design a real-world automation project and debug the workflows.

Reference Books:	
1.	Learning Robotic Process Automation, Alok Mani Tripathi, March 2018, Packt Publishing, Release ISBN: 9781788470940
2.	Introduction to Robotic Process Automation: a Primer, Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, Institute of Robotic Process Automation.
3.	Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Richard Murdoch.
4.	Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation, Srikanth Merianda
5.	https://www.uipath.com/rpa/robotic-process-automation

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**1**	**1**	**3**	**2**	**-**	**-**	**-**	**1**	**-**	**-**
CO2	**2**	**1**	**1**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**2**	**-**	**2**	**2**
CO4	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**3**	**2**	**2**	**2**

High-3: Medium-2: Low-1

Semester: VI						
AIRCRAFT SYSTEMS **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E01**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:

1	List the various systems involved in the design of an aircraft
2	Demonstrate the technical attributes of all the subsystems of an aircraft
3	Explain the significance of each systems and its subsystems for developing an airplane
4	Demonstrate the integration of the systems with the airplane

Unit-I	**07Hrs**
Flight Control Systems: Primary and secondary flight controls, Flight control linkage system, Conventional Systems, Power assisted and fully powered flight controls.	
Unit – II	**10Hrs**
Aircraft Hydraulic & Pneumatic Systems: Components of a typical Hydraulic system, Working or hydraulic system, Power packs, Hydraulic actuators. Pneumatic system and components, Use of bleed air, Landing gear and braking, Shock absorbers-Retraction mechanism.	
Unit -III	**08Hrs**
Aircraft Fuel Systems: Characteristics of aircraft fuel system, Fuel system and its components, Gravity feed and pressure feed fuel systems, Fuel pumps-classification, Fuel control unit.	
Unit -IV	**07Hrs**
Environmental Control Systems: Air-conditioning system, vapour cycle system, de-icing and anti-icing system, Fire detection- warning and suppression. Crew escape aids. **Engine Systems: Engine** starting sequence, Starting and Ignition systems, Engine oils and a typical lubricating system.	
Unit -V	**07Hrs**
Aircraft Instruments : Instruments displays, panels & layouts, Instrumentation grouping, Navigation instruments, Radio instruments, Hydraulic and Engine instruments. **Air Data Instruments :** Basic air data system and probes, Mach meter, Air speed indicator, Vertical speed indicator, Barometric pressure sensing, Altimeter, Air data alerting system- angle of attack sensing, stall warning, Mach warning, altitude alerting system.	

Course Outcomes:

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

CO1:	Categorise the various systems required for designing a complete airplane
CO2:	Comprehend the complexities involved during development of flight vehicles.
CO3:	Explain the role and importance of each systems for designing a safe and efficient flight vehicle
CO4:	Demonstrate the different integration techniques involved in the design of an air vehicle

Reference Books

1	Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Moir, I. and Seabridge, A.,3rd Edition, 2008, Wiley Publications, ISBN- 978-0470059968

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	3	2	2	-	-	-	1
CO2	2	3	3	3	1	1	1	1	-	-	-	1
CO3	2	2	3	3	1	-	-	-	-	-	-	2
CO4	3	3	3	3	1	2	1	2	-	-	-	1

High-3: Medium-2: Low-1

Semester: VI						
BIO INSPIRED ENGINEERING **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E02**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To familiarize engineering students with basic biological concepts
2	Utilize the similarities noted in nature for a particular problem to bring inspiration to the designer.
3	Explain applications such as smart structures, self-healing materials, and robotics relative to their biological analogs
4	To gain an understanding that the design principles from nature can be translated into novel devices and structures.

Unit-I	**08 Hrs**
Introduction to biological systems: General and Special biomolecules, Plant, animal and microbial cell types, Somatic and Sensory system. Plant process - Photosynthesis. Neural networks, Neuron models–Signal encoding architecture, Synaptic plasticity–Supervised, unsupervised and reinforcement learning, Evolution of artificial neural networks–Hybrid neural systems with case study Harvesting Desert Fog.	
Unit – II	**08 Hrs**
Introduction to Biomimetics: Introduction to micro architectural aspects. Structures and physical functions of biological composites of engineering – related case study: Camera from eyes, clothing designs and hooks from Velcro Criteria for future materials design and processing. Computation Cellular systems: Cellular automata – modelling with cellular systems with cellular systems – artificial life – analysis and synthesis of cellular systems: Nature's Water Filter.	
Unit –III	**08 Hrs**
Engineering of synthetic organs: Growth, development and principle of artificial skins, hearing aids, artificial limbs, artificial lungs and artificial lever. Implants-working principle of pacemaker, Breast Implants, Artificial Eye Lenses, Blood sugar monitoring, artificial heart. Application of Spine Screws, Rods and Artificial Discs, Metal Screws, Pins, Plates and Rods	
Unit –IV	**07 Hrs**
Biosimilars: Introduction, characteristics and bioequivalence. Criteria for Bioequivalence, Development of Biosimilars, Statistical Methods for Assessing Biosimilarity, Issues on Immunogenicity Studies, Regulatory Requirements, Stability Analysis of Biosimilar Products, Challenges involved in Biosimilars.	
Unit –V	**08 Hrs**
Biomechatronics: Introduction to MEMS based devices, Evolution of behavioural systems, learning in behavioural systems – co evolution of body and control. Behaviour in cognitive science and artificial intelligence. Biological inspiration for robots, Robots as biological models and robotics behaviour, Application of sleek scale of shark skin.	

Course Outcomes: After completing the course, the students will be able to

CO1:	Remember and explain the concepts of biological and physiological processes
CO2:	Elucidate the basic principles for design and development of biological systems.
CO3:	Differentiate biological phenomena to support inspiration for visual and conceptual design problems

CO4:	Develop technical solutions to customer needs by utilizing a variety of bio-inspiration techniques.

Reference Books	
1	Yoseph Bar-Cohen. Biomimetics: Biologically Inspired Technologies D. Floreano and C. Mattiussi, "Bio-Inspired Artificial Intelligence", CRC Press, 2018. ISBN: 1420037714, 9781420037715.
2	Bououdina, Mohamed. Emerging Research on Bioinspired Materials Engineering. IGI Global, 2016. ISBN: 1466698128, 9781466698123.
3	Christopher H. M. Jenkins. Bio-Inspired Engineering. Momentum Press, 2011. ISBN: 1606502255, 9781606502259.
4	Göran Pohl, Werner Nachtigall. Biomimetics for Architecture & Design: Nature - Analogies – Technology. Springer, 2019. ISBN: 3319191209, 978331919120

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover the entire unit having the same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	-	-	1	3	2	-	1	1	1	-
CO2	3	3	2	3	2	-	1	2	-	1	2	-
CO3	2	2	2	3	3	3	2	2	-	1	2	2
CO4	2	2	3	3	2	-	1	2	1	-	-	-

High-3: Medium-2: Low-1

Semester: VI						
SUSTAINABLE TECHNOLOGY (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E03**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the fundamental concepts related to interaction of industrial and ecological systems.
2	Understand the basic concepts of life cycle assessment.
3	Demonstrate life cycle assessment methodology using appropriate case studies.
4	Use concepts of systems-based, trans-disciplinary approach to sustainability.

Unit-I	**08 Hrs**
Introduction to sustainability: Introduction to Sustainability Concepts and Life Cycle Analysis, Material flow and waste management, Chemicals and Health Effects, Character of Environmental Problems	
Unit – II	**07 Hrs**
Environmental Data Collection and LCA Methodology: Environmental Data Collection Issues, Statistical Analysis of Environmental Data, Common Analytical Instruments, Overview of LCA Methodology. – Goal, Definition.	
Unit –III	**08 Hrs**
Life Cycle Assessment: Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Benefits and Drawbacks. **Wet Biomass Gasifiers:** Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages.	
Unit –IV	**08 Hrs**
Design for Sustainability: Green Sustainable Materials, Environmental Design for Sustainability. **Dry Biomass Gasifiers:** Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems:	
Unit –V	**08 Hrs**
Case Studies: Odor Removal for Organics Treatment Plant, Bio-methanation, Bioethanol production. Bio fuel from water hyacinth.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society.
CO2:	Identify problems in sustainability and formulate appropriate solutions based on scientific research, applied science, social and economic issues.
CO3:	Apply scientific method to a systems-based, trans-disciplinary approach to sustainability
CO4:	Formulate appropriate solutions based on scientific research, applied science, social and economic issues.

Reference Books	
1	Sustainable Engineering Principles and Practice, Bavik R Bhakshi, 2019, Cambridge University Press, ISBN - 9781108333726.

2	Environmental Life Cycle Assessment, Olivier Jolliet, Myriam Saade-Sbeih, Shanna Shaked, Alexandre Jolliet, Pierre Crettaz , 1st Edition, CRC Press, ISBN: 9781439887660 .
3	Sustainable Engineering: Drivers, Metrics, Tools, and Applications, Krishna R. Reddy, Claudio Cameselle, Jeffrey A. Adams, 2019, John Wiley & Sons, ISBN-9781119493938

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

Semester: VI						
GRAPH THEORY **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E04**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the basics of graph theory and their various properties.
2	Model problems using graphs and to solve these problems algorithmically.
3	Apply graph theory concepts to solve real world applications like routing, TSP/traffic control, etc.
4	Optimize the solutions to real problems like transport problems etc.,

UNIT-I	**07 Hrs**
Introduction to graph theory Introduction, Mathematical preliminaries, definitions and examples of graphs, degrees and regular graphs, sub graphs, directed graphs, in degrees and out degrees in digraphs. **Basic concepts in graph theory** Paths and cycles, connectivity, homomorphism and isomorphism of graphs, connectivity in digraphs.	
UNIT-II	**09 Hrs**
Graph representations, Trees, Forests Adjacency matrix of a graph, Incidence matrix of a graph, Adjacency lists, Trees and properties of trees, Characterization of trees, Centers of trees, Rooted trees, Binary threes, Spanning trees and forests, Spanning trees of complete graphs, An application to electrical networks, Minimum cost spanning trees.	
UNIT-III	**09 Hrs**
Fundamental properties of graphs and digraphs Bipartite graphs, Eulerian graphs, Hamiltonian graphs, Hamiltonian cycles in weighted graphs, Eulerian digraphs. **Planar graphs, Connectivity and Flows** Embedding in surfaces, Euler's formula, Characterization of planar graphs, Kuratowski's theorem, Dual of a planar graphs.	
UNIT-IV	**07 Hrs**
Matchings and Factors Min-Max theorem, Independent sets and covers, Dominating sets, maximum bipartite matching. **Coloring of graphs** The chromatic number of a graph, Results for general graphs, The chromatic polynomial of a graph, Basic properties of chromatic polynomial, chordal graphs, powers of graphs, Edge coloring of graphs	
UNIT-V	**07Hrs**
Graph algorithms Graph connectivity algorithms, Breadth first search and Depth first search, Shortest path algorithms, Dijikstra's shortest path algorithm, Minimum cost spanning tree algorithms, Algorithm of Kruskal's and Prim's.	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore the basics of graph theory.
CO2.	Analyse the significance of graph theory in different engineering disciplines
CO3.	Demonstrate algorithms used in interdisciplinary engineering domains.
CO4.	Evaluate or synthesize any real world applications using graph theory.

Reference Books	
1.	Introduction to graph theory, Douglas B. West, 2nd Edition, 2001, PHI, ISBN- 9780130144003, ISBN-0130144002.
2.	Graph Theory, Modeling, Applications and Algorithms, Geir Agnarsson, Raymond Greenlaw, Pearson Education, 1st Edition, 2008, ISBN- 978-81-317-1728-8.
3.	Introduction to Algorithms, Cormen T.H., Leiserson C. E, Rivest R.L., Stein C., 3rd Edition, 2010, PHI, ISBN:9780262033848

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	-	-	-	-	-	-	1	1	-	-
CO2	2	3	2	1	-	-	-	-	2	2	-	1
CO3	2	2	3	2	-	-	-	-	2	2	-	1
CO4	2	2	3	2	-	1	-	-	2	2	-	1

High-3: Medium-2: Low-1

Semester: VI						
DISASTER MANAGEMENT **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E05**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Study the environmental impact of natural and manmade calamities
2	Learn to analyze and assess risk involved due to disasters.
3	Understand the role of public participation.
4	Learn the management tools and mitigation techniques.

Unit-I	**08 Hrs**
Natural disasters and Disaster management Introduction to natural and Industrial Hazards- floods, landslides, earthquakes, volcanoes, avalanche, cyclones, drought, fire, release of effluents, harmful gases, Blast etc. Prediction and perception. Environmental risk due to project activities. Preparation of on-site and off-site disaster management plans - Pre disaster, actual disaster, Post disaster plans. Relief camp organization. Role of voluntary organization and armed forces during disasters.	
Unit – II	**07 Hrs**
Risk analysis and assessment Basic concept. Purpose of risk analysis. Analytical techniques and tools of risk assessment. Toxicology. Significance of risk. Risk characterization. Risk communication and Management, AI in emergency responses.	
Unit –III	**08 Hrs**
Environmental Impact Assessment (EIA) Definition, Basic concepts and principles of EIA. Regulatory framework in India. Environmental inventory. Base line studies. Over view of EIA studies.	
Unit –IV	**08 Hrs**
Assessment and Methodologies Physical, Biological, Natural resources, Socio economic and cultural environmental assessment. EIA methodologies- Adhoc, Matrix, Checklist approaches. Economic evaluation of impacts- cost benefits of EIA. Public participation in environmental decision making. Procedures for reviewing EIA analysis and statement. Decision methods for evaluation of alternatives.	
Unit –V	**08 Hrs**
Disaster Mitigation and Management Introduction, types, modes of disaster management, tools and techniques, primary and secondary data. Natural disasters its causes and remedies-Earthquake hazards-Causes and remedies, Flood and Drought assessment, causes and remedies, Landslides-causes and remedies. Fire hazards in buildings, Fire hazard management, Traffic management, Cyclones and hurricanes, inter department cooperation. Regional and global disaster mitigation.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the different types of disasters and manage the pre and post disaster situation.
CO2:	Estimate and communicate the risk by conducting the risk assessment and Environmental Impact Assessment
CO3:	Identify the methods of disaster mitigation based on the basis of the risk assessment.

CO4:	Analyze and evaluated the impact of measures adopted to mitigate the impacts.

Reference Books	
1	Environmental Impact Analysis Hand Book, John G Rau and David C Wooten, Edition: 2013, ISBN: 978-0070512177.
2	Introduction to environmental Impact assessment, John Glasson, RikiTherivel, Andrew Chadwick, Edition: 2012, Research Press, ISBN:000-0415664705.2005, Reliance Publishing House, New Delhi.
3	Natural Disaster Reduction, Girish K Mishrta, G C Mathew (eds), Edition, 2005, Reliance Publishing House, New Delhi,
4	Remote Sensing and Image Interpretation, Thomas M. Lillisand and R.W. Keifer, 6th Edition, 2002, John Wiley, ISBN:9780470052457.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) + 30 (Q) + 20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	1	-	-	1	1	-	-	-	-	-
CO2	-	2	1	-	-	2	1	1	-	-	-	-
CO3	-	2	1	-	-	2	1	3	-	-	-	-
CO4	-	1	1	-	-	3	2	1	-	-	-	-

High-3: Medium-2: Low-1

Semester: VI						
WEARABLE ELECTRONICS **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E06**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Explain the types and application of wearable sensor.
2	Describe the working of sensitivity, conductivity and energy generation in wearable devices.
3	Explain the various facets of wearable application, advantage & challenges.
4	Understand different testing and calibration in wearable devices.

Unit-I	**08 Hrs**
Introduction: world of wearable (WOW), Role of wearable, The Emerging Concept of Big Data, The Ecosystem Enabling Digital Life, Smart Mobile Communication Devices, Attributes of Wearables, Taxonomy for Wearables, Advancements in Wearables, Textiles and Clothing, Applications of Wearables. [Ref 1: Chapter 1.1]	
Unit – II	**08 Hrs**
Wearable Bio and Chemical Sensors: Introduction, System Design, Microneedle Technology, Sampling Gases, Types of Sensors, Challenges in Chemical Biochemical Sensing, Sensor Stability, Interface with the Body, Textile Integration, Power Requirements, Applications: Personal Health, Sports Performance, Safety and Security, Case studies. [Ref 1: Chapter 2.1]	
Unit –III	**07 Hrs**
Smart Textile: Conductive fibres for electronic textiles: an overview, Types of conductive fibre, Applications of conductive fibres, Bulk conductive polymer yarn, Bulk conductive polymer yarn, Techniques for processing CPYs, Wet-spinning technique, Electrospinning technique, case studies, Hands on project in wearable textile: Solar Backpack, LED Matrix wallet. [Ref 2: Chapter 1,2] &. [Ref 3: Chapter 6,9]	
Unit –IV	**08 Hrs**
Energy Harvesting Systems: Introduction, Energy Harvesting from Temperature Gradient, Thermoelectric Generators, Dc-Dc Converter Topologies, Dc-Dc Converter Design for Ultra-Low Input Voltages, Energy Harvesting from Foot Motion, Ac-Dc Converters, Wireless Energy Transmission, Energy Harvesting from Light, Case studies. [Ref 1: Chapter 4.1]	
Unit –V	**08 Hrs**
Wearable antennas for communication systems: Introduction, Background of textile antennas, Design rules for embroidered antennas, Integration of embroidered textile surfaces onto polymer substrates, Characterizations of embroidered conductive, textiles at radio frequencies, RF performance of embroidered textile antennas, Applications of embroidered antennas. [Ref 2: Chapter 10]	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe the different types and wearable sensors, textile, energy harvesting systems and antenna
CO2:	Analysis measurable quantity and working of wearable electronic devices.
CO3:	Determine & interpret the outcome of the wearable devices and solve the design challenges
CO4:	Analyse and Evaluate the wearable device output parameter in real time scenario or given problem statement.

Reference Books	
1	Wearable Sensors: Fundamentals, Implementation and Applications, Edward Sazonov, Michael R. Neuman Academic Press, 1st Edition, 2014, ISBN-13: 978-0124186620.
2	Electronic Textiles: Smart Fabrics and Wearable Technology, Tilak Dias, Woodhead Publishing; 1st Edition, ISBN-13: 978-0081002018.
3	Make It, Wear It: Wearable Electronics for Makers, Crafters, and Cosplayers, McGraw-Hill Education, 1st Edition, ISBN-13: 978-1260116151.
4	Flexible and Wearable Electronics for Smart Clothing: Aimed to Smart Clothing, Gang Wang, Chengyi Hou, Hongzhi Wang, Wiley, 1st Edition, ISBN-13: 978-3527345342
5	Printed Batteries: Materials, Technologies and Applications, Senentxu Lanceros-Méndez, Carlos Miguel Costa, Wiley, 1st Edition, ISBN-13: 978-1119287421

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	3	-	-	-	-	-	-		-	-
CO2	3	2	2	3	-	-	-	2	2		-	-
CO3	2	2	3	3	-	-	-	2	2		-	-
CO4	3	3	3	3	2	3	2	3	3	3	2	3

High-3: Medium-2: Low-1

Semester: VI						
ENERGY AUDITING AND MANAGEMENT **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E07**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**
Course Learning Objectives: The students will be able to						
1	Understand the need for energy audit, energy management and the concepts of both.					
2	Explain Processes for energy audit of electrical systems.					
3	Design and develop processes for energy audit of mechanical systems.					
4	Prepare the format for energy audit of buildings and lighting systems.					

Unit-I	**06 Hrs**
Types of Energy Audit and Energy-Audit Methodology: Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training. **Survey Instrumentation**: Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data Acquisition System, **Energy Audit of a Power Plant**: Indian Power Plant Scenario, Benefit of Audit, Types of Power Plants, Energy Audit of Power Plant.	
Unit – II	**10 Hrs**
Electrical-Load Management: Electrical Basics, Electrical Load Management, Variable-Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses. **Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling. **Energy Audit of Pumps, Blowers and Cooling Towers:** Pumps, Fans and Blowers, Cooling Towers	
Unit -III	**10 Hrs**
Energy Audit of Boilers: Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. **Energy Audit of Furnaces:** Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency **Energy Audit of Steam-Distribution Systems** :S team as Heating Fluid, Steam Basics, Requirement of Steam, Pressure, Piping, Losses in Steam Distribution Systems, Energy Conservation Methods	
Unit –IV	**07 Hrs**
Compressed Air System: Classification of Compressors, Types of Compressors, Compressed Air – System Layout, Energy – Saving Potential in a Compressed – Air System. **Energy Audit of HVAC Systems:** Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Impact of Refrigerants on Environment and Global Warming, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE.	
Unit –V	**06 Hrs**
Energy Audit of Lighting Systems: Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities.	

Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the need for energy audit, prepare a flow for audit and identify the instruments needed.
CO2:	Design and perform the energy audit process for electrical systems.
CO3:	Design and perform the energy audit process for mechanical systems
CO4:	Propose energy management scheme for a building

Reference Books	
1	Handbook of energy audit, Sonal Desai, Kindle Edition, 2015, McGraw Hill Education, ISBN: 9339221346, 9789339221348
2	Energy management handbook, Wayne C Turner and Steve Doty, 6th Edition, 2015, CRC Press, ISBN: 0-88173-542-6
3	Energy management, Sanjeev Singh and Umesh Rathore, 1st Edition, 2016, Katson Books, ISBN 10: 9350141019, ISBN 13: 9789350141014
4	Energy audit of building systems, Moncef Krarti, 2nd Edition, 2010, CRC Press ISBN: 9781439828717

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	1	2	3	2	1	1	1	2
CO2	3	3	2	2	2	2	3	2	1	1	2	2
CO3	3	3	2	2	2	2	3	2	1	1	2	2
CO4	3	3	2	2	2	2	3	3	1	1	2	2

High-3: Medium-2: Low-1

Semester: VI						
VIRTUAL INSTRUMENTATION & APPLICATIONS (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E08**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understanding the difference between conventional and graphical programming
2	Differentiating the real time and virtual instrument.
3	Analyzing the basics of data acquisition and learning the concepts of data acquisition with LabVIEW
4	Developing a real time application using myRIO and myDAQ programming concepts.

Unit-I	**07 Hrs**
Basic of Virtual Instrumentation, Introduction to Lab VIEW, Components of LabVIEW and Labels., Controller, Indicators data types, wiring tool, debugging tools, Creating Sub-Vis, Boolean, - Mechanical action- switch, and latch actions, Enum, Text, Ring, Type Def, Strict Type Def.	
Unit – II	**09 Hrs**
For Loop, While Loop , Shift registers, stack shift register , feedback node, and tunnel , elapsed time, wait function, Case structures, formula node, Sequence structures, Local and Global variables.	
Unit –III	**09 Hrs**
Arrays and clusters, Visual display types- graphs, charts, XY graph, Introduction to String Functions, LabVIEW String Functions, Typical examples, File Formats, File I/O Functions, File operation	
Unit –IV	**07 Hrs**
Design Pattern- Producer-Consumer Model, Event Structure Model, Master-Slave Model, State Machine Model, Synchronization using Semaphore, Introduction to DAQ System, Measurement and Automation Explorer, DAQ Assistants, Analysis Assistants, Instrument Assistant, Real time application using myDAQ Configured it as Virtual labs, Counters, Low level Lab-VIEW Program,	
Unit –V	**07 Hrs**
Signal Processing Application- Fourier transforms, Power spectrum, Correlation methods, windowing & flittering , Real time application using myRIO, Communication protocol (SPI, I2C, UART) for Embedded Applications, Configure myRIO for speed control of DC Motor using encoder, Keypad application, LCD, IR Sensor, , and onboard sensors. Development of control system, Image acquisition and processing	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Remember and understand the fundamentals of Virtual Instrumentation and data Acquisition.
CO2:	Apply the theoretical concepts to realize practical systems.
CO3:	Analyze and evaluate the performance of Virtual Instrumentation Systems.
CO4:	Create a VI system to solve real time problems using data acquisition.

Reference Books	
1	Jovitha Jerome, Virtual instrumentation Using LabVIEW,4th Edition, 2010, PHI Learning Pvt.Ltd , ISBN: 978-8120340305

2	Sanjay Gupta & Joseph John**,** Virtual Instrumentation Using LabVIEW, 2nd Edition, 2017, Tata McGraw Hill Publisher Ltd, ISBN : 978-0070700284
3	Lisa. K. Wills**,** LabVIEW for Everyone**,** 2nd Edition, 2008, Prentice Hall of India, , ISBN : 978-013185672
4	Garry Johnson, Richard Jennings, LabVIEW Graphical Programming, , 4thEdition , 2017, McGraw Hill Professional, ISBN: 978-1259005336

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks are executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	-	-	-	-	-	1	1	-	1
CO2	1	3	2	1	2	-	-	-	1	1	-	1
CO3	2	2	3	3	3	-	-	-	1	1	-	2
CO4	1	2	2	3	3	1	0	2	3	2	1	2

High-3: Medium-2: Low-1

Semester: VI						
SYSTEMS ENGINEERING (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E09**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:

1.	Understand the Life Cycle of Systems.
2.	Explain the role of Stake holders and their needs in organizational systems.
3.	Develop and Document the knowledge base for effective systems engineering processes.
4.	Apply available tools, methods and technologies to support complex high technology systems.
5.	Create the frameworks for quality processes to ensure high reliability of systems.

UNIT-I	**06 Hrs**
System Engineering and the World of Modem System: What is System Engineering?, Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems.	
UNIT – II	**10 Hrs**
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. **Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems.	
UNIT – III	**10 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	
UNIT – IV	**07 Hrs**
Engineering Design: Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	
UNIT – V	**06 Hrs**
Production: Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems.	

Operations and support: Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the Life Cycle of Systems.
CO2:	Explain the role of Stake holders and their needs in organizational systems.
CO3:	Develop and Document the knowledge base for effective systems engineering processes.
CO4:	Apply available tools, methods and technologies to support complex high technology systems.
CO5:	Create the frameworks for quality processes to ensure high reliability of systems.

Reference Books:	
1.	Systems Engineering – Principles and Practice, Alexander Kossoaikoff, William N Sweet, 2012, John Wiley & Sons, Inc, ISBN: 978-81-265-2453-2
2.	Handbook of Systems Engineering and Management, Andrew P. Sage, William B. Rouse, 1999, John Wiley & Sons, Inc., ISBN 0-471-15405-9
3.	General System Theory: Foundation, Development, Applications, Ludwig von Bertalanffy, 1973, Penguin University Books, ISBN: 0140600043, 9780140600049.
4.	Systems Engineering and Analysis, Blanchard, B., and Fabrycky, W., 5th edition, 2010, Prentice Hall, Saddle River, NJ, USA

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	-	-	-	-	1	-	-	-	-	-	1
CO2	-	2	3	-	1	-	-	1	-	-	2	-
CO3	-	3	-	-	-	2	2	1	-	3	2	-
CO4	-	-	2	1	-	-	-	-	-	-	-	-
CO5	1	1	-	2	-	1	2	-	3	-	-	-

High-3: Medium-2: Low-1

Semester: VI						
INTRODUCTION TO MOBILE APPLICATION DEVELOPMENT **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Comprehend the knowledge on essentials of android application development.
2	Demonstrate the basic and advanced features of android technology.
3	Develop the skills in designing and building mobile applications using android platform.
4	Create. debug and publish innovative mobile applications using android Platform.
5	Comprehend the knowledge on essentials of android application development.

Unit-I	**08 Hrs**
Introduction: Smart phone operating systems and smart phones applications. Introduction to Android, Installing Android Studio, creating an Android app project, deploying the app to the emulator and a device. UI Design: Building a layout with UI elements, Layouts, Views and Resources, Text and Scrolling Views. Activities and Intents, The Activity Lifecycle, Managing State, Activities and Implicit Intents, Testing, debugging, and using support libraries, The Android Studio Debugger, Testing android app, The Android Support Library.	
Unit – II	**08 Hrs**
User experience: User interaction, User Input Controls, Menus, Screen Navigation, Recycler View, Delightful user experience, Drawables, Styles, and Themes, Material Design, Providing Resources for Adaptive Layouts, Testing app UI, Testing the User Interface	
Unit –III	**08 Hrs**
Working in the background: Background Tasks, AsyncTask and Async Task Loader, Connect to the Internet, Broadcast Receivers, and Services. Triggering, scheduling and optimizing background tasks – Notifications, Scheduling Alarms, and Transferring Data Efficiently	
Unit –IV	**08 Hrs**
All about data: Preferences and Settings, Storing Data, Shared Preferences, App Settings. Storing data using SQLite - SQLite Primer, SQLite Database. Sharing data with content providers. Loading data using loaders. Using Selection Widgets and Debugging, Displaying and Fetching Information, Using Dialogs and Fragments, Advanced Android Programming: Internet, Entertainment, and Services, Implementing drawing and animations. Displaying web pages and maps, communicating with SMS and emails. Creating and consuming services - Location based services, Sensors.	
Unit –V	**07 Hrs**
Hardware Support & devices: Permissions and Libraries, Performance and Security. Firebase and AdMob, Publish and Polish, Multiple Form Factors, Using Google Services.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Comprehend the basic features of android platform and the application development process. Acquire familiarity with basic building blocks of Android application and its architecture.
CO2:	Apply and explore the basic framework, usage of SDK to build Android applications incorporating Android features in developing mobile applications.
CO3:	Demonstrate proficiency in coding on a mobile programming platform using advanced Android technologies, handle security issues, rich graphics interfaces, using debugging and troubleshooting tools.
CO4:	Create innovative applications, understand the economics and features of the app marketplace by offering the applications for download.

Reference Books	
1	Android Programming, Phillips, Stewart, Hardy and Marsicano, Big Nerd Ranch Guide, 2nd Edition, 2015, ISBN-13 978-0134171494
2	Android Studio Development Essentials - Android 6, Neil Smyth, 2015, Createspace Independent Publishing Platform, ISBN: 9781519722089
3	Android Programming – Pushing the limits, Eric Hellman, 2013, Wiley, ISBN-13: 978-1118717370
4	Professional Android 2 Application Development, Reto Meier, Wiley India Pvt.Ltd 1st Edition, 2012, ISBN-13: 9788126525898
5	Beginning Android 3, Mark Murphy, Apress Springer India Pvt Ltd, 1st Edition, 2011, ISBN-13: 978-1-4302-3297-1
6	Android Developer Training - https://developers.google.com/training/android/ Android Testing Support Library - https://google.github.io/android-testing-support-library/

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	-	3	-	-	-	-	-	-	2
CO2	3	-	-	-	3	-	-	-	-	-	1	2
CO3	-	3	3	-	3	-	1	-	-	2	1	3
CO4	3	3	3	1	3	2	1	2	2	1	1	3

High-3: Medium-2: Low-1

Semester: VI						
INDUSTRIAL AUTOMATION **(GROUP E: GLOBAL ELECTIVE)** **(THOERY)**						
Course Code	**:**	**18G6E11**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Identify the various types of Actuators, sensors and switching devices used in industrial automation.
2	Understand the fundamentals of CNC, PLC and Industrial robots.
3	Describe the functions of hardware components for automation
4	Prepare simple manual part programs for CNC and Ladder logic for PLC.
5	Demonstrate the ability to develop suitable industrial automation systems using all the concepts

Unit-I	**06 Hrs**

Overview of Automation in Industry

Basic kinds of Industrial type equipment, automation and process control, mechanization vs automation, continuous and discrete control, basic elements of an automated system, advanced automation functions, levels of automation, basic automation circuits.

Unit-II	**10 Hrs**

Sensors and Industrial Switching elements.

Sensor terminology, Classification of sensors and transducers, Limit switch, Temperature sensors, Light sensors, position sensors, inductive and capacitive proximity sensors, optical encoders, Relays, Solenoids, moving part logic elements, fluidic elements, timers, comparisons between switching elements.

Industrial Automation Synthesis

Introductory principles, basic automation examples, meaning of the electrical and mechanical latch, automation circuits with sensors, design regulations and implementation.

Unit-III	**10 Hrs**

Logical Design of Automation Circuits

Postulates and theorems of Boolean algebra, Classical state diagrams, state diagrams with sensors, step by step transition due to discrete successive signal, state diagram with time relays, components state diagram method, state diagrams and minimum realisations, sequential automation systems, Applications – Bi directional lead screw movable worktable with two speeds, Palindromic movement of a worktable with memory.

Elements of electro pneumatic actuation

Basic elements of pneumatic system, pneumatic cylinders, Symbolic representations of pneumatic and electrical switching devices, Indirect control of double acting cylinders, memory control circuit, cascading design, automatic return motion, quick exhaust valve circuit, and cyclic operation of a cylinder, pressure sequence valve and time delay valve circuits. Automatic return motion, Separating similar balls, Stamping device.

Unit-IV	**06 Hrs**

Numerical Control and Robotics

Numerical control, components of CNC, classification, coordinate systems, motion control strategies, interpolation, NC words, Simple part programming for turning, milling and drilling. Components of the robot, base types, grippers, Configurations and simple programming using VAL.

Unit-V	07 Hrs
Programmable logic control systems Internal structure, principles of operation, latching, ladder diagrams, programming instructions, types of timers, forms of counters, writing simple ladder diagrams from narrative description and Boolean logic. Programming exercises on motor control in two directions, traffic control, cyclic movement of cylinder, conveyor belt control, alarm system, sequential process, and continuous filling operation on a conveyor.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall and Illustrate the application of sensors actuators, switching elements and inspection technologies in industrial automation.
CO2:	Build the circuit diagrams for fluid power automation, Ladder diagrams for PLC and identify its application areas.
CO3:	Evaluate CNC part programs for 2D complex profiles, perform machining and turning centres interfaced with Robots.
CO4:	Develop a suitable industrial automated system integrating all of the above advanced automation concepts

Reference Books	
1.	Stamatios Manesis, George Nikolakopoulos, 'Introduction to Industrial Automation', CRC Press, 2018, ISBN - 978-1-4987-0540-0
2.	David W. Pessen, 'Industrial automation; Circuit design and components', Wiley India, 1st Edition, 2011, ISBN –13–978–8126529889.
3.	Joji P, 'Pneumatic Controls', Wiley India, 1st Edition, ISBN – 978–81–265–1542–4.
4.	Petruzella, Frank D, Programmable logic controllers, McGraw-Hill, 4th Edition, 2013, ISBN-13: 978-0-07-351088-0

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30 (Q) + 50 (T) + 20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	2	2	-	3	1	-	-	-	1	-	1
CO2	2	2	3	2	2	-	-	-	1	2	-	1
CO3	2	2	3	3	2	-	-	-	-	2	-	-
CO4	3	3	3	2	2	-	-	-	-	2	-	1

High-3: Medium-2: Low-1

Semester: VI						
MOBILE NETWORK SYSTEM AND STANDARDS (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E12**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives: The students will be able to

1	Understand the essential principles of cellular communication and factors that might degrade the performance.
2	Describe the second-Generation pan-European digital mobile cellular communication standards.
3	Analyze the 3G cellular technologies including GPRS and UMTS.
4	Compare the existing and future trends in Wireless technologies.

Unit-I	**07 Hrs**
Principle of Cellular Communication: Cellular Terminology, Cell Structure and Cluster, Frequency Reuse Concept, Cluster size and System Capacity, Method of Locating Co-channel cells, Frequency Reuse distance, Co-channel Interference and Signal Quality, Co-channel interference Reduction Methods.	
Unit – II	**08 Hrs**
Basic Cellular system: Consideration of components of a cellular system- A basic cellular system connected to PSTN, Main parts of a basic cellular system, Operation of a Cellular system, Performance criteria- Voice quality, Trunking and Grade of Service, Spectral Efficiency of FDMA and TDMA systems.	
Unit –III	**09 Hrs**
Second generation Cellular Technology: GSM: GSM Network Architecture, Identifiers used in GSM System, GSM channels, Authentication and Security in GSM, GSM Call Procedure, GSM Hand-off Procedures. **IS-95:** Forward Link, Reverse Link, Soft-handover in IS-95.	
Unit –IV	**08 Hrs**
3G Digital Cellular Technology: GPRS: GPRS technology, GPRS Network Architecture, GPRS signalling, Mobility Management in GPRS. **UMTS:** UMTS Network Architecture, UMTS Interfaces, UMTS Air Interface Specifications, UMTS Channels.	
Unit –V	**08 Hrs**
Wireless Personal Area Networks: Network architecture, components, Bluetooth, Zigbee, Applications. **Wireless Local Area networks:** Network Architecture, Standards, Applications. **Wireless Metropolitan Area Networks:** IEEE 802.16 standards, advantages, WMAN Network architecture, Protocol stack.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the concepts and terminologies for Cellular Communication.
CO2	Analyze the Architecture, Hand-off and Security aspects in 2G and 3G Networks.
CO3	Compare the performance features of 2G and 3G Cellular Technologies.
CO4	Analyze and Compare the architectures of various Wireless technologies and standards.

Reference Books	
1	Wireless Communications, T.L. Singal, 2nd Reprint 2011, Tata McGraw Hill Education Private Limited, ISBN: 978-0-07-068178-1.
2	Wireless and Mobile Networks Concepts and Protocols, Dr.Sunil Kumar S Manvi, 2010, Willey India Pvt. Ltd., ISBN: 978-81-265-2069-5.
3	Wireless Communication, Upena Dalal, 1st Edition, 2009, Oxford higher Education, ISBN-13:978-0-19-806066-6.
4	Wireless Communications Principles and practice, Theodore S Rappaport, 2nd Edition, Pearson, ISBN 97881-317-3186-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	-	2	-	-	-		-	-	
CO2	3	2	3	-	2	-	-	-	2	-	-	
CO3	3	3	-	2	2	-	-	-	2	-	-	3
CO4	3	2	2	-	2	-	-	-	2	-	-	3

High-3: Medium-2: Low-1

Semester: VI						
THIN FILM NANO DEVICE FABRICATION TECHNOLOGY (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E13**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Basic understanding of vacuum and related technology
2	Knowledge of growth, optimization and characterization of thin films and nanostructures
3	Design appropriate growth technique for desired application
4	Fabricate and Evaluate thin film nano devices for advanced applications

Unit-I	**08 Hrs**

Vacuum Technology:

Introduction (KTG, classification of Vacuum), Gas transport and pumping, Q-rate calculation, Basics of Vacuum - Principles of different vacuum pumps: Rotary, Roots, Diffusion, Turbo molecular, and Cryogenic pumps, getter pumps (NEG), sublimation pump (TSP); differential pumping, Measurement of vacuum - Concept of Capacitance Manometer, Pirani and Penning gauges.

Unit – II	**08 Hrs**

Substrate Surfaces& Thin Film Nucleation:

Atomic view of substrate surfaces, Thermodynamic aspects of nucleation, Kinetic processes in nucleation and growth, experimental studies of nucleation and growth (Brief)

Defects in Thin Films:

0-D (point defects), 1-D (line defects), 2&3-D (grain boundaries, stacking faults, crystal twins, voids and precipitates), strain mismatch, Ion implantation defects (Amorphization), Effects of defects on the film (Electrical resistivity, PN junction leakage current, diffusion, Mechanical stress), defect propagation in films

Unit –III	**08 Hrs**

Fabrication Techniques

Chemical Approaches: Electro Spinning and spin coating routes, Pulsed electro-chemical vapor deposition (PECVD)

Physical Approaches: Metalorganic chemical vapor deposition (MOCVD), Atomic Layer Deposition (ALD) - pulsed laser deposition, Arc plasma deposition.

Lithography: Photo/FIB techniques, Etching process: Dry and Wet etching

Unit –IV	**07 Hrs**

Characterization Techniques

Surface morphology measurements: Kelvin-probe Force Microscopy (KFM), Surface X-ray Diffraction (SXRD), **Vacancy type defects and interfacial surface chemistry**: Positron Annihilation Lifetime Spectroscopy (PALS), Angle Resolved X-ray Photoelectron spectroscopy (ARXPS) Point**, line defects, grain boundary studies**: Transmission Electron microscopy (TEM), UV Visible Spectroscopy (UV-Vis)

Unit –V	**08 Hrs**

Silicon wafer fabrication – Wafer to cell formation - I-V characteristics and spectral response of c-Si solar cells. Factors limiting the efficiency, Differences in properties between crystalline silicon and amorphous (a-Si) silicon

Thin Film Solar Cells: Principle of multi-junction cells, Structure and fabrication of GaInP/GaAs/Ge triple junction solar cell - Cell configuration – techniques used for the deposition of each layer- cell characteristics, optical efficiency measurements (brief)

Thin film Nano Biosensor: Biosensors and nanotechnology, Basic biosensor architecture, Biosensor

(receptor/antigen) recognition element, Biosensor transducer (electrochemical, optical, thermal, mass), Glucowatch ™, Examples in cancer detection **Field Effect Transistors**: Overview, Basic Structure, I-V Characteristics, Lateral transport of electrons in different regions of transistors.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Choose the right choice of material for the desired application
CO2:	Improve the desired nanostructures and their properties
CO3:	Fabricate appropriate Nanodevices
CO4:	Optimize the nanodevice fabrication process for repeatability.

Reference Books	
1	Solid State Physics, Ashcroft & Mermin, 2nd Edition, Brooks/Cole, 1976, ISBN-13: 978-0030839931
2	Nanotechnology for photovoltaics, Loucas Tsakalakos, 1st Edition, 2010, ISBN 9781420076745.
3	Microfabrication for Industrial Applications, Regina Luttge, 1st Edition, William Andrew,2011, ISBN: 9780815515821.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	-	-	-	-	-	-		-	2
CO2	3	2	2	2	-	-	-	-	-		-	2
CO3	2	3	3	2	2	1	1	1	-	1	-	2
CO4	2	3	3	2	2	2	2	2	2	2	-	2

High-3: Medium-2: Low-1

Semester: VI						
CHEMISTRY OF ADVANCED ENERGY STORAGE DEVICES FOR E-MOBILITY (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E14**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basic concepts of advanced storage devices.
2	Apply the basic concepts of storage devices for E-mobility in the area of automotive engineering.
3	Impart knowledge of electrochemistry to analyze the problems associated with electric/hybrid vehicles.
4	Develop knowledge of battery management system and recycling of storage devices.

Unit-I	**07 Hrs**
Introduction of Energy Storage Systems in Electric vehicles: Background of alternative energy sources and sustainability. Introduction of E-mobility: Overview of land, marine and space vehicle electrification. Vehicle performance and fuel economy and characteristics. Electric vehicles configuration, energy and power requirements for various HEVs and EVs Vehicles. Fundamentals of battery technology in hybrid vehicles.	
Unit – II	**08 Hrs**
Advanced Lithium ion Battery Technology for Electric-vehicles: Basic concepts of lithium batteries, Advanced Lithium batteries for E-mobility: Cell construction, battery components, principle of operation, electrode fabrication, electrolytes, battery modules and packs. Construction, working and future applications of Li-polymer batteries, Li-S battery, Li-Air battery, Li-iron sulfide cells and solid-state batteries.	
Unit –III	**08 Hrs**
Future Scope in non- Lithium Batteries: Limitations of lithium batteries. Construction, components, working and applications of Non-Lithium batteries: Sodium-battery, Magnesium battery, Nickel Metal Hydride Battery, Zebra cells, Vanadium and iron-based batteries, Ni-Hydrogen batteries. Advanced batteries for transportation: Ni-MH battery, horizontal plate Pb-Acid batteries. Advantages and applications of non-lithium batteries.	
Unit –IV	**08 Hrs**
Chemistry of Alternative Storage Devices: Introduction to super capacitor, material characteristics. Construction, working and applications of Super capacitors and Ultra capacitor for E mobility: Double layer Super capacitors, Aqueous super capacitor, organic based super capacitors, asymmetric super capacitors and Ultra capacitors. Advanced battery-super capacitor hybrids for large vehicles, Battery-Fuel cell hybridization for transportation applications, Battery-Solar Cell (Photovoltaic) hybridization, and advanced energy storage devices for back-up of solar energy.	
Unit –V	**08 Hrs**
Battery Maintenance and Recycling: Battery Management Systems (BMS), Fundamentals of battery management systems and controls. Battery Thermal Management: Passive cooling – PCM systems, Active cooling – Liquids & air systems. Battery Recycling Technologies: Technology and economic aspects of battery recycling. Environmental safety in battery recycling process. Regulations and safety aspects of high voltage batteries: battery standards, safe handling of lithium batteries.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understanding the fundamentals of advanced batteries, super capacitors and fuel cells for electric vehicles.
CO2:	Applying the chemistry knowledge used for hybridization of various energy storage and conversion devices for vehicle electrification.
CO3:	Analyses of battery management, safety, global market trends for large format batteries.
CO4:	Evaluation of efficiency of a battery with respect to cost, environmental safety, material, energy consumption, reuse and recycling.

Reference Books	
1	Battery reference book, T. R. Crompton., 3rd edition, NEWNES Reed Educational and Professional Publishing Ltd 2000, ISBN: 07506 4625 X.
2	Batteries for Electric Vehicles, D. A. J. Rand, R. Woods, and R. M. Dell, Society of Automotive Engineers, Warrendale PA, 2003. ISBN 10: 0768001277.
3	Lithium Batteries, Science and Technology, GA. Nazri and G. Pistoa, Kluwer Academic Publisher, 2003, ISBN 978-0-387-92675-9.
4	Battery Technology Handbook, H. A. Kiehne, Marcel Dekker, NYC, 2003. ISBN: 0824742494 9780824742492.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	2	-	-	-	-	1	-	1
CO2	3	3	2	2	2	-	-	-	1	1	-	1
CO3	2	2	3	3	2	-	-	-	3	1	2	1
CO4	3	3	2	3	2	-	-	-	2	1	3	1

High-3: Medium-2: Low-1

Semester: VI						
ADVANCED STATISTICAL METHODS (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E15**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Adequate exposure to understand the basic knowledge on classification and regression trees that form the foundation for analyzing data.
2	Use the concepts of cluster analysis and conjoint analysis techniques arising in various fields.
3	Apply the concepts of discriminant analysis and factor analysis which have great significance in engineering practice.
4	Demonstrate the practical importance of regression and loglinear models.

Unit-I	**07 Hrs**
Classification and Regression Trees: Introduction, the Basic Tree Model, Categorical or Quantitative Predictors, Regression Trees, Classification Trees, Stopping Rules, Pruning and Cross-Validation, Loss functions, Geometry.	
Unit – II	**07 Hrs**
Cluster Analysis: Introduction, Types of Clustering, Correlations and Distances, Hierarchical Clustering, Partitioning via K-means, Additive Trees.	
Unit –III	**08 Hrs**
Conjoint Analysis: Introduction, Additive Tables, Multiplicative Tables, Computing Table Margins based on an Additive Model, Applied Conjoint Analysis.	
Unit –IV	**08 Hrs**
Discriminant Analysis and Factor Analysis: Introduction, Linear Discriminant Model, Linear discriminant function, Discriminant analysis, Principal Component, Factor Analysis, Principal Components versus Factor Analysis, Applications and Caveats.	
Unit –V	**09 Hrs**
Logistic Regression and Loglinear Models: Introduction, Binary Logit, Multinomial Logit, Conditional Logit, Discrete Choice Logit, Stepwise Logit, Fitting a Loglinear Model.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore the fundamental concepts of statistical methods arising in various fields engineering.
CO2:	Apply the knowledge and skills of statistical techniques to understand various types of analysis.
CO3:	Analyze the appropriate statistical techniques to solve the real-world problem and to optimize the solution.
CO4:	Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations.

Reference Books	
1	Statistics I, SYSTAT 10.2, ISBN 81-88341-04-5.
2	Nonparametric Statistical Inference, Gibbons J., D., and Chakraborti, S., 4th Edition, 2003, Marcel Decker, New York. ISBN: 0-8247-4052-1.

3	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, 2014, John Wiley & Sons, ISBN: 13 9781118539712, ISBN (BRV):9781118645062.
4	An Introduction to Multivariate Analysis, T. W. Anderson, 3rd Edition, 2003, John Wiley & Sons, New Jersey, ISBN: 0-471-36091-0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

Semester: VI						
MATHEMATICAL MODELING **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E16**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Adequate exposure to understand the basic knowledge of mathematical modeling.
2	Use the concepts of discrete process models arising in various fields.
3	Apply the concepts of modeling of nano liquids which have great significance in engineering practice.
4	Demonstrate the practical importance of graph theoretic models, variational problem and dynamic programming.

Unit-I	**07 Hrs**
Elementary Mathematical Modeling: Basic concepts. Real world problems, (Science and Engineering), Approximation of the problem, Steps involved in modeling. Linear growth and decay model, Logistic model, Model of mass-spring-dashpot (present in shock absorbed, mechanical engineering problems), Chemical reaction, Drug absorption from blood stream. Motion of a projectile, Current flow in electrical circuits (LCR).	
Unit – II	**07 Hrs**
Discrete Process Models: Introduction to Difference equations, Introduction to discrete models-simple examples, Mathematical modeling through difference equations in economics, finance, population dynamics and genetics and probability theory.	
Unit –III	**08 Hrs**
Modeling of Nano Liquids: Nano liquids-Basic concepts, Mathematical modeling of nano liquids-Buongiorno Model (Two phase model): Relative importance of the nanoparticle transport mechanisms. Conservation equation for two phase nano liquids: The Continuity equation, Momentum equation and Energy equation.	
Unit –IV	**08 Hrs**
Graph Theoretic Models: Mathematical modeling through graphs-Models in terms of undirected graphs, directed graphs, signed graphs and weighted graphs. Problems with engineering applications.	
Unit –V	**09 Hrs**
Variational Problem and Dynamic Programming: Optimization principles and techniques, Mathematical models of variational problem and dynamic programming, Problems with engineering applications.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore the fundamental concepts of mathematical models arising in various fields engineering.
CO2:	Apply the knowledge and skills of discrete and continuous models to understand various types of analysis.
CO3:	Analyze the appropriate mathematical model to solve the real-world problem and to optimize the solution.
CO4:	Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations.

Reference Books	
1	Mathematical Modeling, J. N. Kapur, 1st Edition, 1998, New Age International, New Delhi, ISBN: 81-224-0006-X.
2	Case studies in mathematical modeling, D. J. G. James and J. J. Mcdonald, 1981, Stanly Thames, Cheltonham, ISBN: 0470271779, 9780470271773.
3	Modeling with difference equations, D. N. Burghes, M. S. Borrie, Ellis Harwood, 1981, ISBN 13: 9780853122869.
4	Mathematical Modeling: Models, Analysis and Applications, Sandip Banerjee, 2014, Chapman and Hall/CRC Textbook, ISBN 9781439854518.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

VI Semester						
FOUNDATIONAL COURSE ON ENTREPRENEURSHIP (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E17**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	To make participants self-discover their innate flow, entrepreneurial style, and identify problems worth solving thereby becoming entrepreneurs
2	To handhold participants on lean methodology to craft value proposition and get ready with lean canvas
3	To create solution demo by conducting customer interviews and finding problem-solution fit for building Minimum Viable Product (MVP)
4	To make participants understand cost structure, pricing, revenue types and importance of adopting shared leadership to build good team
5	To help participants build a strong brand and identify various sales channels for their products and services
6	To take participants through basics of business regulations and other legal terms along-with understanding of Intellectual Property Rights

Unit-I	**08 Hrs**
Self-Discovery and Opportunity Discovery Finding the Flow; Effectuation; Identifying the Effectuation principles used in activities; Identifying Problem Worth Solving; Design Thinking; Brainstorming; Presenting the Identified problems; Identifying the Entrepreneurial Style.	
Unit – II	**08 Hrs**
Customer, Solution and Lean Methodology Customers and Markets; Segmentation and Targeting; Identifying Jobs, Pains, and Gains and Early Adopters; Crafting Value Proposition Canvas (VPC); Presenting VPC; Basics of Business Model and Lean Approach; Sketching the Lean Canvas; Risks and Assumptions; Presenting Lean Canvas.	
Unit – III	**07 Hrs**
Problem-Solution Fit and Building MVP Blue Ocean Strategy - Plotting the Strategy Canvas; Four Action Framework: Eliminate-Reduce-Raise-Create Grid of Blue Ocean Strategy; Building Solution Demo and Conducting Solution Interviews; Problem-Solution Fit; Building MVP; Product-Market Fit; Presenting MVP.	
Unit – IV	**07 Hrs**
Financial Planning & Team Building Cost Structure - Estimating Costs; Revenues and Pricing: Revenue Streams, Revenue Types, Identifying Secondary Revenue Streams, Estimating Revenue and Price; Profitability Checks; Bootstrapping and Initial Financing; Practising Pitch; Shared Leadership; Hiring and Fitment, Team Role and Responsibilities.	
Unit – V	**09 Hrs**
Marketing, Sales, Regulations and Intellectual Property Positioning and Branding; Channels; Sales Planning; Project Management; Basics of Business	

Regulations; How to Get Help to Get Started; Patents, Trademark, Licensing, Contracts; Common Legal mistakes, Types of Permits, Tax Registration Documents, Compliance; Infringement and Remedies, Ownership and Transfer.

Course Outcomes: After completing the course, the students will be able to	
CO1	Showcase the ability to discern distinct entrepreneurial traits
CO2	Know the parameters to assess opportunities and constraints for new business ideas
CO3	Understand the systematic process to select and screen a business idea
CO4	Design strategies for successful implementation of ideas
CO5	Create Business Model and develop Minimum Viable Product

Reference Books:	
1	Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly Media, Maurya, A., 2012.
2	Entrepreneurship. Roy, R., 2012. Oxford University Press
3	Intellectual Property Law in India. Gupta, T. S., 2011. Kluwer Law International
4	Flow: The Psychology of Optimal Experience. Czikszentmihalyi, M., 2008. Harper Perennial Modern Classics
5	Effectuation: Elements of Entrepreneurial Expertise. Sarasvathy, S. D., 2009. Edward Elgar Publishing Ltd.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	-	-	-	-	2	-	1	2	2	-	1
CO2	1	1	-	-	-	3	2	3	1	2	-	1
CO3	-	1	-	-	-	2	1	3	3	3	3	3
CO4	-	1	2	2	3	-	-	-	1	-	2	1

High-3: Medium-2: Low-1

VI Semester				
PROFESSIONAL PRACTICE – II EMPLOYABILITY SKILLS AND PROFESSIONAL DEVELOPMENT OF ENGINEERS				
Course Code	**:**	**18HS68**		**CIE Marks: 50**
Credits: L:T:P	**:**	**0:0:1**		**SEE Marks: 50**
Hours:	**:**	**18 Hrs/Semester**		**CIE Duration: 02Hrs**
Course Learning Objectives: The students will be able to				
1	Improve qualitative and quantitative problem solving skills.			
2	Apply critical and logical thinking process to specific problems.			
3	Ability to verbally compare and contrast words and arrive at relationships between concepts, based on verbal reasoning.			
4	Applying good mind maps that help in communicating ideas as well as in technical documentation			

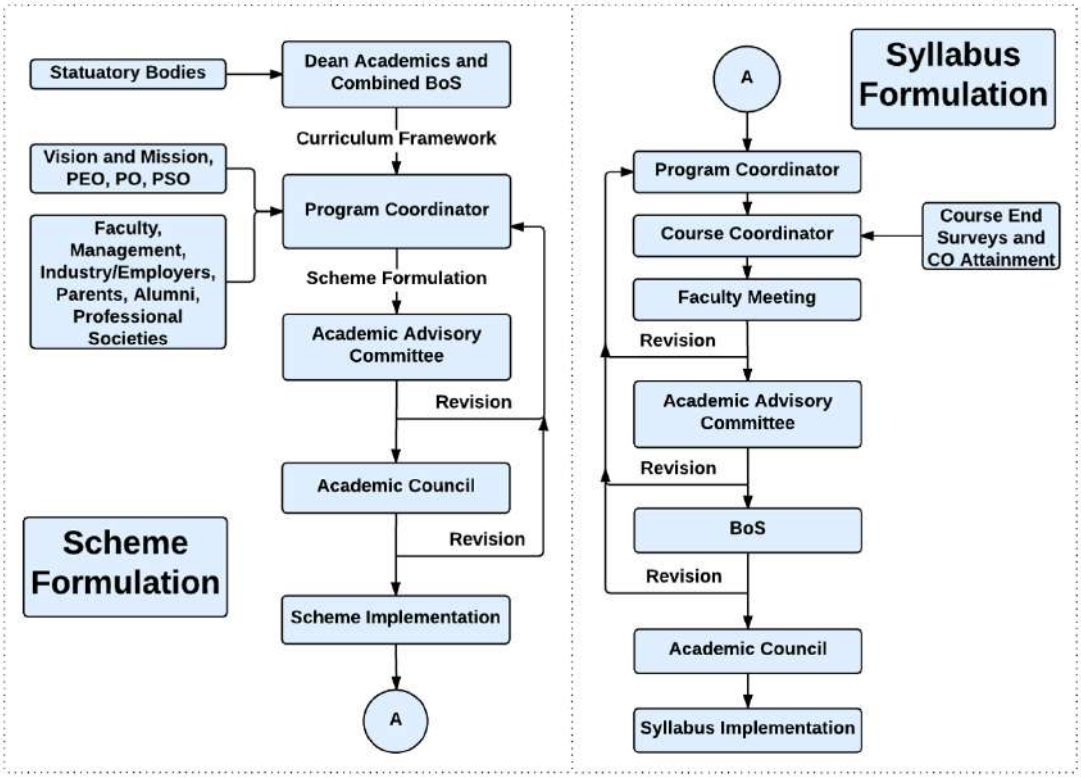
V Semester	
UNIT-I	**06 Hrs**
Aptitude Test Preparation- Importance of Aptitude tests, Key Components, Quantitative Aptitude – Problem Solving, Data Sufficiency, Data Analysis - Number Systems, Math Vocabulary, fraction decimals, digit places etc. **Reasoning and Logical Aptitude, -** Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. Analytical Reasoning, Critical Reasoning.	
UNIT-II	**06 Hrs**
Verbal Analogies - What are Analogies, How to Solve Verbal Analogies & developing Higher Vocabulary, Grammar, Comprehension and Application, Written Ability. Non- Verbal Reasoning, Brain Teasers. Creativity Aptitude. **Group Discussion-** Theory &Evaluation : Understanding why and how is the group discussion conducted, The techniques of group discussion, Discuss the FAQs of group discussion, body language during GD.	
UNIT-III.A	**06 Hrs**
Resume Writing- Writing Resume, how to write effective resume, Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts.	
VI Semester	
UNIT-III.B	**06 Hrs**
Technical Documentation - Introduction to technical writing- Emphasis on language difference between general and technical writing, Contents in a technical document, Report design overview & format Headings, list & special notes, Writing processes, Translating technical information, Power revision techniques, Patterns & elements of sentences, Common grammar, usage & punctuation problems.	
UNIT-IV	**06 Hrs**
Interview Skills -a) Personal Interviews , b) Group Interviews , c) Mock Interviews - Questions asked & how to handle them, Body language in interview, Etiquette, Dress code in interview, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on stress interviews, technical interviews, General HR interviews etc.	
UNIT-V	**06 Hrs**
Interpersonal Relations - Optimal Co-existence, Cultural Sensitivity, Gender sensitivity Adapting to the Corporate Culture- Capability & Maturity Model, Decision Making Analysis, Brain Storm. Adapting to the Corporate Culture.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Inculcate employability skill to suit the industry requirement.
CO2:	Analyze problems using quantitative and reasoning skills
CO3:	Exhibit verbal aptitude skills with appropriate comprehension and application.
CO4:	Focus on Personal Strengths and Competent to face interviews and answer
Reference Books	
1.	The 7 Habits of Highly Effective People, Stephen R Covey Free Press, 2004 Edition, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie General Press, 1st Edition, 2016, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book ,2014 Edition, Tata McGraw Hill ISBN: 9781259058738

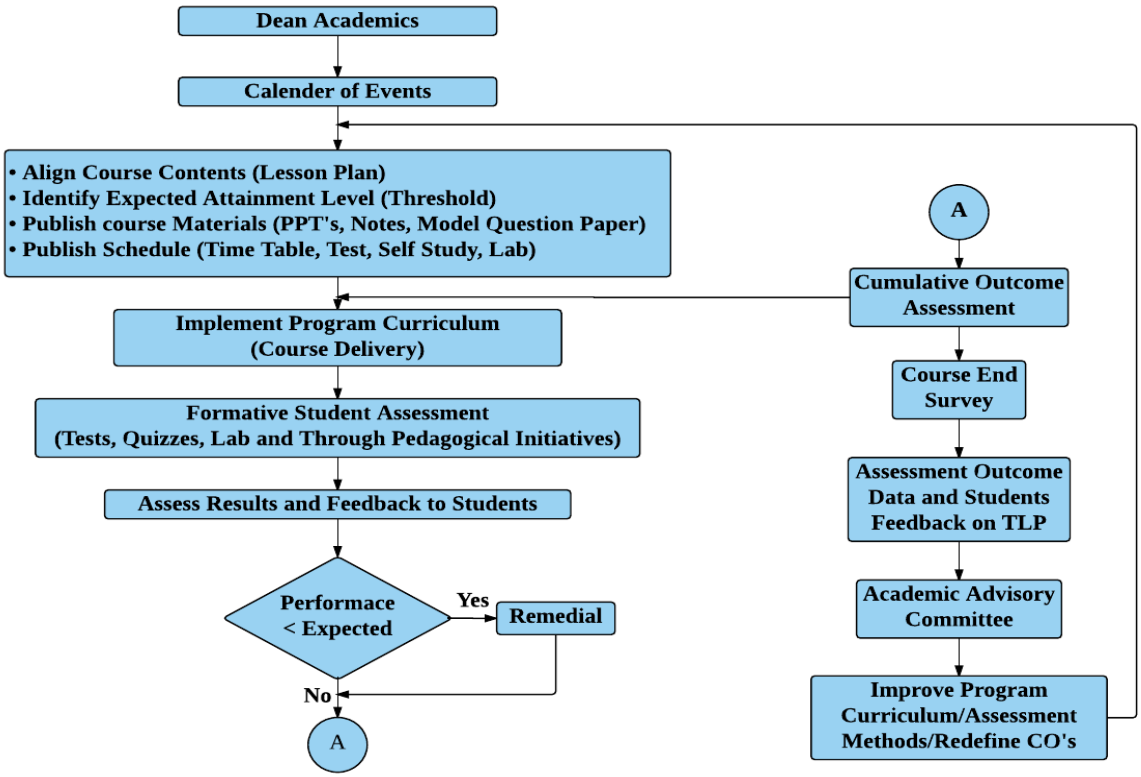
Scheme of Continuous Internal Examination and Semester End Examination

Phase	Activity	Weightage
Phase I V Sem	CIE will be conducted during the 5th semester and evaluated for 50 marks. The test will have two components. The Quiz is evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks. The test & quiz will assess the skills acquired through the training module. SEE is based on the test conducted at the end of the 5thsemester The test will have two components a Quiz evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks.	50%
Phase II VISem	During the 6thsemester a test will be conducted and evaluated for 50 marks. The test will have two components a Short Quiz and Questions requiring descriptive answers. The test & quiz will assess the skills acquired through the training module. SEE is based on the test conducted at the end of the 6thsemester The test will have two components. The Quiz evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks	50%
Phase III At the end of VISem	At the end of the VI Sem Marks of CIE (5thSem and 6thSem) is consolidated for 50 marks (Average of Test1 and Test 2 (CIE 1+CIE2)/2. At the end of the VISem Marks of SEE (5thSem and 6thSem) is consolidated for 50 marks (Average of CIE 1 and CIE 2 (CIE 1+CIE2)/2.	

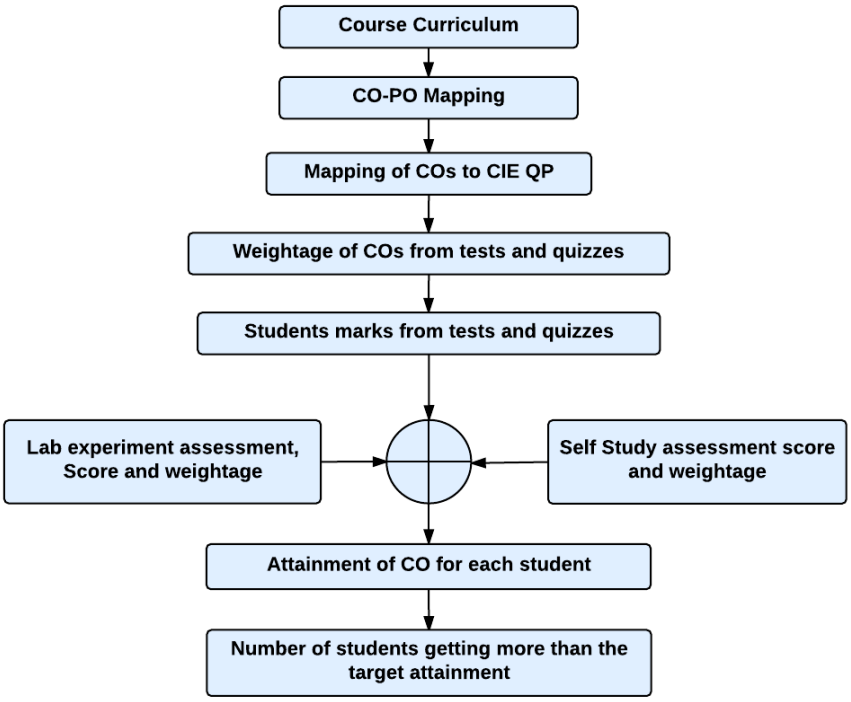
Curriculum Design Process



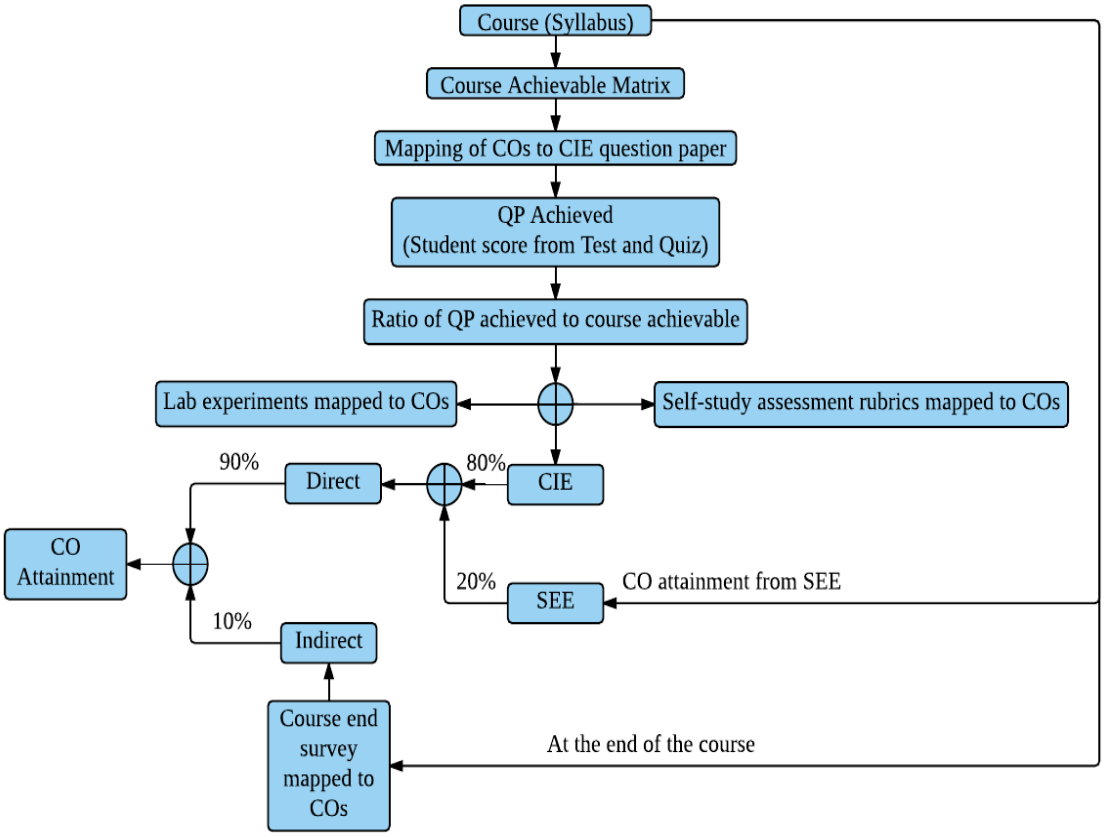
Academic Planning And Implementation



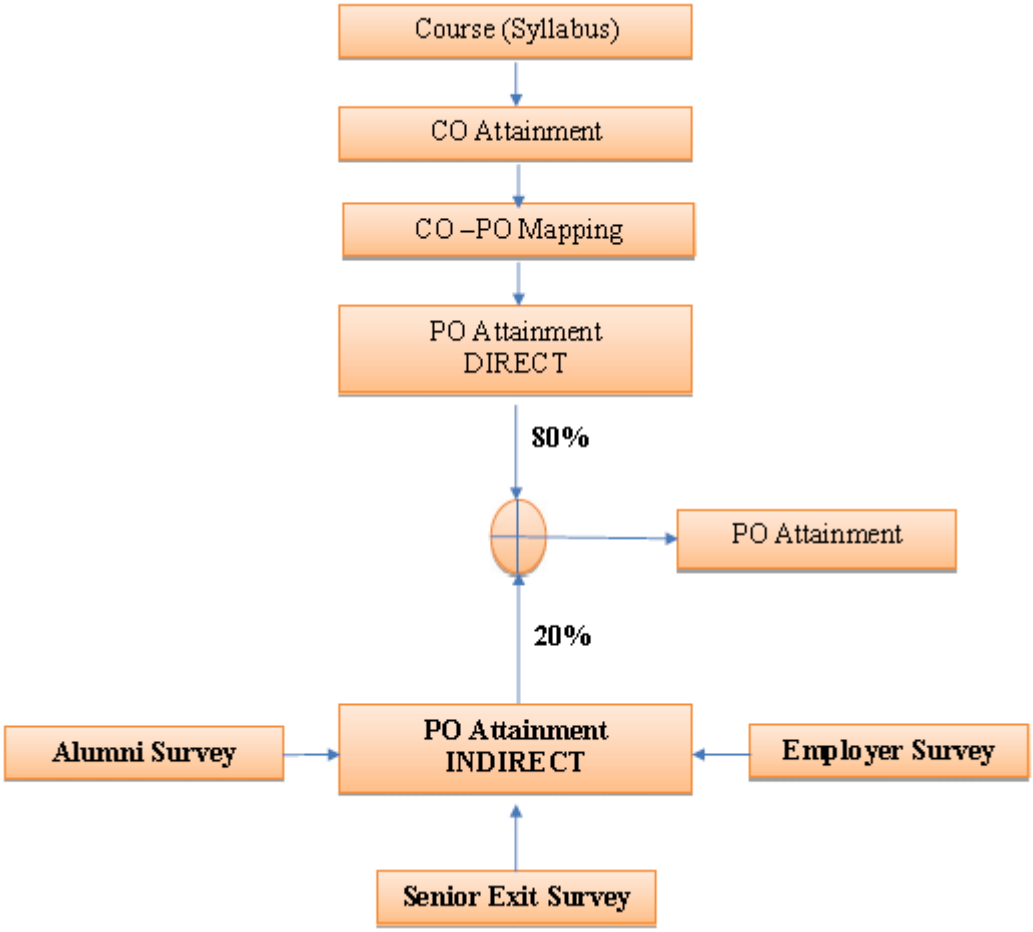
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.