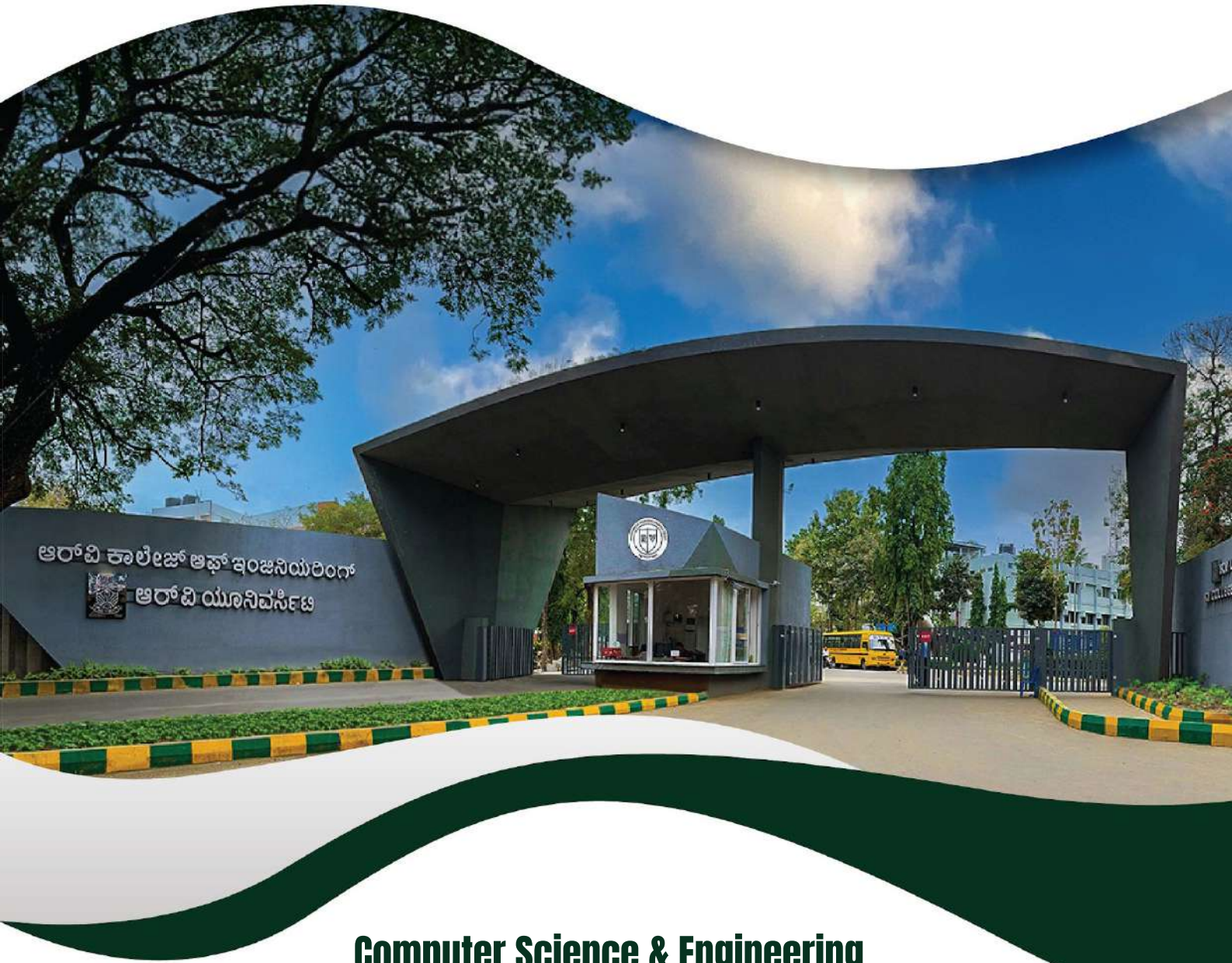
RV College of Engineering®



Computer Science & Engineering

(Data Science)

Bachelor of Engineering (B.E)

Scheme And Syllabus Of VII & VIII Semester
(2022 Scheme)

B.E. Programs : AI, AS, BT, CD, CH, CS, CV, CY, EC, EE, EI, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs : All Departments are recognized as Research Centres by VTU Except AI & AS

2025

RV College of Engineering®

SINCE 1963

NAAC GRADE A+ ACCREDITED INSTITUTION

SHAPING VISIONARIES, CRAFTING INNOVATORS

An autonomous institution affiliated with VTU, Belagavi, and approved by AICTE and UGC, New Delhi

- **RV SATELLITE-1 (RVSAT - 1)** India's First Microbiological Payload, launched by RVCE students in December 2024
- **NCC** - Best Institution Award of Karnataka and Goa Directorate (2019, 2022, 2023 & 2025)

₹50 Cr.

MoU with **TATA Technologies** to establish Centre for Invention, Innovation, Incubation & Training

Placements

₹92 LPA	250+	92%	₹10 LPA
Highest Package	Recruitment Partners	Placement Rate	Median Salary

Rankings

99th	1501+	601+	NBA	IIRF 2025	NPTEL
NIRF Ranking 2024 in Engineering Category	Times Higher Education World University Rankings-2025	Times Higher Education Asia University Rankings-2025	UG and PG programs accredited multiple times	Engineering ranking India National - 01 State - 01 Zone - 01	Local Chapter Ranking 2025 National – 09 State – 01

Research and Centres

37 Skill Labs

General Skills, Domain Skills, Interdisciplinary Skills

- Bosch Rexroth
- Mercedes Benz
- Morris Garage
- Boston AI System
- Toyota Kirloskar
- Vision Astra EV Academy

Outcome Based Education (OBE) emphasizing on experiential learning, research-based learning and skill-based learning

20	8
Centres of Excellence	Centres of Competence

80	65	46
Patents filed	Patents published	Patents granted

32	₹30 Cr.
Innovative & Cultural activity teams	Research and projects consultancy (last 5 years)

16 Research Centres in niche areas

- Autonomous Vehicles
- Nanomaterials and Devices
- Hydrogen and Green Technology
- Extended Reality
- Healthcare
- E-mobility
- IoT and Sensors
- Smart Antenna System
- Computational Genomics
- Quantum Computing

Programs and Faculty

- **13 UG** Programs; **1420 (2025)** annual sanctioned intake
- **13 PG** Programs **390 (2025)** annual sanctioned intake
- **Ph.D.** Programs in all departments
- **500+** Faculty Members and Staff

CET / KEA Code: **E005**
COMED-K Code: **E095**
PGCET Code (MTech): **T857**
PGCET Code (MCA): **C463**

State-of-the-Art infrastructure

- **Innovation Center**
- **Gymnatorium**
- **Hostels**
- **Labs & Workshops**

Alumni

36,000 +	100+
Alumni across the globe	RVCE alumni in civil service

RVCE Reconnect - USA edition, our first International Alumni Meet

NUMBER OF ATTENDEES

650	120
San Jose	Seattle

Mr. Suresh Katta, RVCE alumnus & Chairman Emeritus of Saama Group, USA and **Mr. Anil Kumble,** RVCE alumnus & former Indian cricketer, were the Guests of Honour at the alumni meets held in San Jose & Seattle, USA.

Collaborations with International universities

125 MoUs with Industry, Institutions & Research Establishments

thws · Fachhochschule Dortmund · Technische Hochschule Rosenheim · HTWD · The University of Iowa · FIU Florida International University · Saint Peter's University · Kennesaw State University · RWTH Aachen University

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Go, change the world®

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Computer Science & Engineering

(Data Science)

Bachelor of Engineering (B.E)

Scheme And Syllabus Of VII & VIII Semester
(2022 Scheme)

B.E. Programs : AI, AS, BT, CD, CH, CS, CV, CY, EC, EE, EI, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs : All Departments are recognized as Research Centres by VTU Except AI & AS

2025

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

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 take up 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.	PY	Physics
9.	CM	Chemistry
10.	MA	Mathematics
11.	AS	Aerospace Engineering
12.	AI & ML	Artificial Intelligence & Machine Learning
13.	BT	Biotechnology
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	CV	Civil Engineering
17.	EC	Electronics & Communication Engineering
18.	EE	Electrical & Electronics Engineering
19.	EI	Electronics & Instrumentation Engineering
20.	ET	Electronics & Telecommunication Engineering
21.	IM	Industrial Engineering & Management
22.	IS	Information Science & Engineering
23.	ME	Mechanical Engineering
24.	CD	Computer Science & Engineering (Data Science)
25.	CY	Computer Science & Engineering (Cyber Security)
26.	CI	Computer Science & Engineering (Artificial Intelligence & Machine Learning)

INDEX

* **Indicates choosing of any one of the following option**		
XX373TA	Professional Core Course with tutorial	3(Theory) + 1(Tutorial) = 4 credits
XX373IA	Professional Core Course with laboratory component	3(Theory) + 1(Practical) = 4credits

Computer Science & Engineering [Data Science]

SEVENTH SEMESTER

Slo. No.	BoS	Course Code	Course Title	L	T	P	Credits	Category	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
									Theory	Lab	Hours	Theory	Lab
1	HS	HS251TA	Indian Knowledge System	3	0	0	3	Theory	100	***	3	100	***
2	AI	AI372IA	Stream Processing and Analytics	3	0	1	4	Theory + Practice	100	50	3	100	50
3	CD	CD373TA	Operations Research	3	1	0	4	Theory + Tutorial	100	***	3	100	***
4	CD	CD374TFX	Professional Core Elective -IV (Group F)	3	0	0	3	Theory	100	***	3	100	***
5	XX	XX375TGX	Institutional Electives -II (Group G)	3	0	0	3	Theory	100	***	3	100	***
6	CD	CD376SI	Summer Internship	0	0	3	3	Internship	***	100	3	***	100
				Total			20						

VIII SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category
			L	T	P	Total		
1	CD481P	Major Project	0	0	12	12	CD	Project
		Total				**12**		

Group F: Professional Core Elective – IV Courses				
Sl. No.	BoS	Course Code	Course Title	Credits
5	CD	CD374TFA	Synthetic Data Generation	3
	CD	CD374TFB	Time Series Analysis	3
	AI	AI374TFC	Ethical Artificial Intelligence	3
	CD	CD374TFD	Extended Reality	3

Group G: Institutional Elective – I Courses				
Sl. No.	**BoS**	**Course Code**	**Course Title**	**Credits**
1.	AI	AI375TGA	Data and Story Telling	3
2.	AS	AS375TGB	Aircraft Systems	3
3.	BT	BT375TGC	Health Care Technologies	3
4.	CH	CH375TGD	Green and Hydrogen Technology	3
5.	CM	CM375TGE	Chemistry of materials and molecular analysis	3
6.	CS	CS375TGF	Prompt Engineering	3
7.	CV	CV375TGG	Solid Waste Management and Statutory rules	3
8.	CV	CV375TGH	Freight Transportation Systems and Logistics	3
9.	EC	EC375TGI	IoT for smart systems	3
10.	EE	EE375TGJ	E Mobility	3
11.	EI	EI375TGK	Disease and Diagnostics an Engineering Perspective	3
12.	ET	ET375TGL	Space Technology and Applications	3
13.	IEM	IM375TGM	Project Management	3
14.	IEM	IM375TGN	Global Supply chain management	3
15.	MA	MA375TGO	STATISTICAL METHODS FOR ENGINEERS	3
16.	ME	ME375TGP	Industry 5.0	3
17.	PY	PY375TGQ	Principles of Astrophysics	3
18.	MA	MA375TGR	Mathematics of Music	3
19.	HSS	HS375TGS	Cognitive Psychology	3
20.	HSS	HS375TGT	Principles & Practices of Cyber Law	3

Semester: VII						
INDIAN KNOWLEDGE SYSTEM **Common Course** **Theory**						
Course Code	**:**	**HS271T**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction of Indian Knowledge Systems (IKS): Perception and prologue, Historicity of IKS, Indian Traditional Knowledge, Nature and scope, kinds of traditional knowledge, Transition from traditional to western knowledge. The IKS Corpus, Vedic Corpus, Indian Philosophical Systems.	
Unit – II	**09 Hrs**
Foundational Concepts of Mathematics and Science & Technology: Linguistics; Pānini's work on Sanskrit Grammar, Phoenetics, Ashtadhyayi's vyakarana. Number System and Units of Measurement: concept of zero, Piṅgala and the Binary system. Knowledge: Framework & Classifications: Prameya, Pramana, Samsaya.	
Unit –III	**09 Hrs**
Science, Engineering & Technology in IKS: Mathematics; Arithmetic, geometry, trigonometry and algebra, Chanda Sastra of Pingala. Astronomy: Elements of the Indian Calendar, Āryabhaṭīya and the Siddhāntic Tradition, Panchanga, Astronomical Instruments (Yantras) and Jyotish. Engineering & Technology: Metals & Metal Working; Wootz Steel, Iron and Steel in India, Metals and Metal working Technology, Lost-wax casting of idols and artefacts, Dyes and Painting Technology, The art of making perfumes.	
Unit –IV	**09 Hrs**
Yoga and Ayurveda: Tridoṣas, Triguṇa System, Body-Mind-Intellect-Consciousness Complex, Sixty-four art forms and occupational skills (64 Kalas). **Irrigation Systems and Water management Practices Town Planning & Architecture**: Indian Architecture in India, Vāstu Śāstra; Eight limbs of Vāstu, Town Planning; Temple Architecture	
Unit –V	**09 Hrs**
Governance, Public Administration & Management: Rāmāyaṇa on great attributes, Arthaśāstra – Governance & Administration, Janapada, Durga, Kosa, Danda, Mitra. IKS & United Nations Sustainable development goals. Safeguarding traditional Indian Knowledge.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the nature, scope, and historical development of Indian Knowledge Systems and differentiate traditional knowledge from modern scientific paradigms
CO2	Analyze the foundational concepts of Indian contributions to linguistics, mathematics, and science, including works of Pānini, Piṅgala and others
CO3	Evaluate the applications of traditional Indian technologies in areas such as astronomy, metallurgy, architecture, and medicine.
CO4	Assess the relevance of Indian Knowledge Systems in the context of sustainable development goals and propose methods to safeguard and integrate IKS in contemporary society

Reference Books	
1.	Introduction to Indian Knowledge System Concepts & Applications, B Mahadevan, Vinayaka Rajat Bhat, R N Nagendra Pavana, PHI Learning publishers, ISBN-13: 978-9391818203

2.	Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230
3.	Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334,
	Suggested Web Links:
1.	https://www.youtube.com/watch?v=LZP1StpYEPM
2.	http://nptel.ac.in/courses/121106003/
3.	http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63 (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4.	https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5.	https://unctad.org/system/files/official-document/ditcted10_en.pdf
6.	http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
7.	https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom"s Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks**. FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS.**	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
Stream Processing and Analytics **Category: PROFESSIONAL CORE COURSE** **(Theory and Practice)**						
Course Code	**:**	**AI372IA**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3 +3 Hours**

Unit-I	**09 Hrs**
Introducing Streaming Data: What is Real time system – Differences between real time and streaming systems – architectural blue print – security for streaming systems – scaling **Data Ingestion:** Common Interaction patterns – scaling the interaction patterns – Faulty tolerance	
Unit – II	**09 Hrs**
Data Transportation: Message queue – Core concepts – security – application of core concepts to business logic **Analysing Streaming Data:** Inflight data analysis – Distributed stream processing architecture – key features of stream processing frame work	
Unit –III	**09 Hrs**
Algorithms for Data Analysis: Accepting constraints and relaxing – Thinking about time – Summarization Technique **Storing the analysed or collected data:** Long time storage – keeping it in memory	
Unit –IV	**09 Hrs**
Introduction to Kafka: Why Kafka – Kafka Eco System – Kafka Origin - Kafka Producers and Consumers	
Unit –V	**09 Hrs**
Building Data Pipe lines – When to use pipe lines – when to use kafka connect vs producer and consumer **Kafka Streams –** Stream Processing design patterns - Architecture over view – How to choose Stream processing framework - Kafka streams by example – word count – stock market statistics – click stream enrichment ,	
Laboratory Component Group of two / three students of same batch are required to build an application using stream processing tools for various real time applications like (i) Real time Sentiment Analysis (ii) Stock Market analysis (iii) Click stream enrichment (iv) In-flight analysis (v) video stream processing etc.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Describe the need and the application of real time and stream processing in real world applications.
CO2	Comprehend and apply the various operations like data ingestion, data communication, data analysis and storage for different streaming data applications.
CO3	Investigate and apply streaming concepts using modern tools to solve problems related to society and industry.
CO4	Demonstrate a prototype application for streaming data using Kafka as a team / individual.
CO5	Demonstrate solutions for societal and environmental concern problems using modern engineering tools through writing effective reports.

Reference Books	
1.	Andrew Psaltis, Streaming Data – Understanding the Real time Pipe Line, Manning Publications, First Edition: 2017, ISBN: 9781617292286
2.	Gwen Shapira, Todd Palino, Rajini Sivaram, Krit Petty, Kafka: The Definitive Guide: Real-Time Data and Stream Processing at Scale, O'Reilly Media, Second Edition, November 2021, ISBN: 978-1-492-08736-6
3.	Tyler Akidau, Slava Chernyak, and Reuven Lax, Streaming Systems, O'Reilly Media , First Edition 2018 , ISBN : 978-1-491-98387-4
4.	Henrique C. M. Andrade , Bugra Gedik , Deepak S. Turaga , Fundamentals of Stream Processing Application Design, Systems, and Analytics , Cambridge University Press 2014 , ISBN 978-1-107-01554-8 Hardback

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing &Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. **THE FINAL MARKS WILL BE 50 MARKS**	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
Student is required to perform Computer Simulation/ Develop a prototype or model as the case may be and present the results in the form a presentation. Further, students have to submit a poster for exhibition and also a report.		
1	Design and development of the project	20
2	Presentation of the working model/simulation results/prototype building	20
3	Viva Voce	10
	TOTAL	**50**

Semester: VII						
OPERATIONS RESEARCH **Category: PROFESSIONAL CORE COURSE** **(Theory)**						
Course Code	**:**	**CD373TA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:1:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L+30T**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 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 – Feasible, Basic Feasible, Degenerate, Solution through Graphical Method. Problems on Product Mix, Blending, Marketing, Finance, Agriculture and Personnel. **Simplex Methods:** Variants of Simplex Algorithm – Use of Artificial Variables.	
Unit – II	**09 Hrs**
Simplex Algorithm: How to Convert an LP to Standard Form, Preview of the Simplex Algorithm, Direction of Unboundedness, Why Does an LP Have an Optimal basic feasible solution, The Simplex Algorithm, Using the Simplex Algorithm to Solve Minimization Problems, Alternative Optimal Solutions, Degeneracy and the Convergence of the Simplex Algorithm, The Big M Method, The Two – Phase Simplex Method.	
Unit –III	**09 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems. **Assignment Problem:** Formulation of the Assignment problem, solution method of assignment problem – Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP)	
Unit –IV	**09 Hrs**
Decision Theory and Decision Trees: Introduction, Steps of Decision-Making Process, Types of Decision-Making Environments, Decision-Making Under Uncertainty – Optimism (Maximax or Minimin) Criterion, Pessimism (Maximin or Minimax) Criterion, Equal Probabilities (Laplace) Criterion, Coefficient of Optimism (Hurwicz) Criterion, Regret (Savage) Criterion, Decision-Making Under Risk - Expected Monetary Value (EMV), Expected Opportunity Loss (EOL), Expected Value of Perfect Information (EVPI), Decision Trees Analysis, Decision-Making with Utilities - Utility Functions, Utility Curve, Construction of Utility Curves	
Unit –V	**09 Hrs**
Network Model: Scope and Definition of Network Models, Minimal Spanning Tree Algorithm, Shortest Route Problem - Examples of the Shortest-Route Applications, Shortest- Route Algorithms, Linear Programming Formulation of the Shortest-Route Problem, Maximal Flow Model - Enumeration of Cuts, Maximal Flow Algorithm, Linear Programming Formulation of Maximal Flow Mode, CPM and PERT – Network Representation, Critical Path Method (CPM) Computations. Construction of the Time Schedule, Linear Programming Formulation of CPM, PERT Networks	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained.
CO2	Determine optimal strategy for Minimization of Cost of shipping of products from source to Destination/ Maximization of profits of shipping products using various methods, Finding initial basic feasible and optimal solution of the Transportation problems.
CO3	Optimize the allocation of resources to Demand points in the best possible way using various techniques and minimize the cost or time of completion of number of jobs by number of persons.
CO4	Formulate Network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems.

Reference Books	
1.	Michael Carter, Camille C. Price, Ghaith Rabadi, Operations Research: A Practical Introduction (Advances in Applied Mathematics) Hardcover – Import, 14 August 2018. ISBN: 978-1498780100
2.	Hamdy A Taha, Operations Research: An Introduction, 10e, Pearson, August 2019. ISBN: 978-9352865277
3.	J K Sharma, Operation Research (Theory and Applications), 4th Edition, 2019, ISBN: 978-0230638853

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (05), Program specific requirements (05), Video based seminar/presentation/demonstration (10), MATLAB (20). **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
SYNTHETIC DATA GENERATION **Category: PROFESSIONAL CORE ELECTIVE-IV (Group-F)** **(Theory)**						
Course Code	**:**	**CD374TFA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**08 Hrs**
Introducing Synthetic Data Generation: Introducing Synthetic Data Generation, Defining Synthetic Data, Synthesis from Real Data, Synthesis Without Real Data, Synthesis and Utility, The Benefits of Synthetic Data, Efficient Access to Data, Enabling Better Analytics, Synthetic Data as a Proxy, Learning to Trust Synthetic Data, Synthetic Data Case Studies. **Implementing Data Synthesis:** When to Synthesize, Identifiability Spectrum, Trade-Offs in Selecting PETs to Enable Data Access, Decision Criteria, PETs Considered, Decision Framework, Examples of Applying the Decision Framework, Data Synthesis Projects, Data Synthesis Steps, Data Preparation, The Data Synthesis Pipeline, Synthesis Program Management	
Unit – II	**08 Hrs**
Getting Started: Distribution Fitting, Framing Data, How Data Is Distributed, Fitting Distributions to Real Data, Generating Synthetic Data from a Distribution, Measuring How Well Synthetic Data Fits a Distribution, The Overfitting Dilemma, A Little Light Weeding. **Evaluating Synthetic Data Utility:** Synthetic Data Utility Framework: Replication of Analysis, Synthetic Data Utility Framework: Utility Metrics, Comparing Univariate Distributions, Comparing Bivariate Statistics, Comparing Multivariate Prediction Models, Distinguishability	
Unit –III	**07 Hrs**
Methods for Synthesizing Data: Generating Synthetic Data from Theory, Sampling from a Multivariate Normal Distribution, Inducing Correlations with Specified Marginal Distributions, Copulas with Known Marginal Distributions, Generating Realistic Synthetic Data, Fitting Real Data to Known Distributions, Using Machine Learning to Fit the Distributions, Hybrid Synthetic Data, Machine Learning Methods, Deep Learning Methods, Synthesizing Sequences. **Identity Disclosure in Synthetic Data:** Types of Disclosure, Identity Disclosure, Learning Something New, Attribute Disclosure, Inferential Disclosure, Meaningful Identity Disclosure, Defining Information Gain, Bringing It All Together, Unique Matches, How Privacy Law Impacts the Creation and Use of Synthetic Data, Issues Under the GDPR, Issues Under the CCPA, Issues Under HIPAA, Article 29 Working Party Opinion.	
Unit –IV	**08 Hrs**
Introduction to GANs: GANs, CTGAN, SurfelGAN, Cycle GANs, SinGAN-Seg, MedGAN, DCGAN, WGAN, SeqGAN, Conditional GAN, BigGAN	
Unit –V	**08 Hrs**

Synthetic Data Generation with Python: Data Generation with Know Distribution, Data with Date information , Data with Internet information, A more complex and comprehensive example, Synthetic Data Generation in Regression Problem, Gaussian Noise Apply to Regression Model, Friedman Functions and Symbolic Regression, Make 3d Plot, Make3d Plot, Synthetic data generation for Classification and Clustering Problems, Classification Problems, Clustering Problems, Generation Tabular Synthetic Data by Applying GANs, Synthetic data Generation

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Analyse the need and context and requirement for synthetic data generation
CO2	Ability to identify the challenges and methodology to synthesise data
CO3	Apply relevant approach and algorithm to generate synthetic data
CO4	Develop and test realtime applications using the synthetic data generated.

Reference Books	
1.	El Emam, Khaled, Lucy Mosquera, and Richard Hoptroff. Practical synthetic data generation: balancing privacy and the broad availability of data. O'Reilly Media, 2020.
2.	Gürsakal, Necmi, Sadullah Çelik, and Esma Birişçi. "Synthetic Data for Deep Learning." Berkeley, CA: Apress. doi 10 (2022): 978-1.
3.	"Synthetic Data: Generation Methods, Challenges and Real-time Applications",R. Nidhya, D. Pavithra, S. Balamurugan, Manish Kumar, S. Karthik ISBN: 978-1-394-34651-6, September 2025

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
PART A		
1	Objective type questions covering entire syllabus	20
PART B (Maximum of TWO Sub-divisions only)		
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
TIME SERIES ANALYSIS **Category: PROFESSIONAL CORE ELECTIVE-IV (Group-F)** **(Theory)**						
Course Code	**:**	**CD374TFB**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction: Examples of time series, Stationary models and autocorrelation function, Estimation and elimination of trend and seasonal components**.**	
Unit – II	**09 Hrs**
Stationary Process and ARMA Models: Basic properties and linear processes, Introduction to ARMA models, properties of sample mean and autocorrelation function, Forecasting stationary time series, ARMA(p, q) processes, ACF and PACF, Forecasting of ARMA processes.	
Unit –III	**09 Hrs**
Modeling and Forecasting with ARMA Processes: Preliminary estimation, Maximum likelihood estimation, Diagnostics, Forecasting, Order selection.	
Unit –IV	**09 Hrs**
Nonstationary and Seasonal Time Series Models: ARIMA models, Identification techniques, Unit roots in time series, Forecasting ARIMA models, Seasonal ARIMA models, Regression with ARMA errors	
Unit –V	**09 Hrs**
Forecasting Techniques: ARAR algorithm, Holt-Winter algorithm, Holt-Winter seasonal algorithm. Estimation of time series models.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Apply the fundamental concepts and examples of time series data, including stationarity, trends, and seasonal components.
CO2	Analyze and model stationary time series using ARMA models, and interpret autocorrelation and partial autocorrelation functions.
CO3	Evaluate the parameter estimation techniques such as maximum likelihood to build and evaluate ARMA models for forecasting.
CO4	Develop and assess models for nonstationary and seasonal time series data using ARIMA and seasonal ARIMA frameworks.
CO5	Employ advanced forecasting algorithms such as ARAR and Holt-Winters methods to real-world time series data using statistical too
Reference Books	

1.	Introduction to Time Series and Forecasting,Brockwell, Peter J. and Davis, Richard A., 2016, 3rd Edition. Springer International Publishing Switzerland. ISBN 978-3-319-29852-8 , 978-3-319-29854-2
2.	Time Series Analysis and Its Applications With R Examples,Robert H. Shumway and David S. Stoffer, Springer, 2011. 3 rd Edition ,ISBN 978-1-4419-7864-6,978-1-4419-7865-3
3.	Galit Shmueli and Kenneth C. Lichtendahl Jr . Practical Time Series Forecasting with R: A Hands-On Guide,2016,3rd Edition, Axelrod Schnall Publishers ,ISBN-10: 099784793X , 9780997847932.
4.	The Analysis of Time Series: An Introduction, Chris Chatfield, 1996, 5th Editi,Publisher: Chapman & Hall , ISBN: 0412716402 , 9780412716409
5.	Forecasting: Methods and Applications, pyros Makridakis , Steven C. Wheelwright , Rob J. Hyndman,2008, 3rd Edition , Wiley Publisher , ISBN-10 8126518529 ,ISBN-13 978-8126518524

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
ETHICAL ARTIFICIAL INTELLIGENCE (Common to AI,CY,CD,IS) Category: Professional Core Elective – IV (Group F) (Theory)						
Course Code	**:**	**AI374TFC**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**9Hrs**
Introduction to AI and ethics - Strong and weak AI, Types of ethics - Descriptive, Normative, Meta, Relationship between ethics and law, Machine ethics examples, Moral Diversity and Testing **Core Ethical Principles**- Bias and Fairness, Transparency and Explainability, Privacy and Security, Robustness and Reliability	
Unit II	**9 Hrs**
Bias and Fairness – Understanding Bias in data and Models – How Bias can impact Decision Making Process, types of Bias , Examples of Real World Cases, Techniques to detect and Mitigate Bias, Implement Bias Detection and Fairness.	
Unit –III	**9Hrs**
Transparency and Explainability - Importance of Transparency and Explainability in AI Models, Methods for Achieving Explainable AI, Tools, Frameworks, and Implementation of Transparency and Explainability, Challenges and Solutions in Achieving Transparency and Explainability	
Unit IV	**9Hrs**
Privacy Concerns in AI - Potential Threats to Privacy , Privacy Attacks in AI Models , Mitigating Privacy Risks in AI **Security Concerns in AI** - Potential Threats to Security , Mitigating Security Risks in AI	
Unit V	**9 Hrs**
Robustness and Reliability - Concepts of Robustness and Reliability- Metrics for Measuring Robustness and Reliability, Challenges in Achieving Robustness , Challenges in Ensuring Reliability – Data Quality, Model Drift, Uncertainty in AI Models	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand, Identify and address ethical principles arising from developing and deploying AI technologies.
CO2	Critically assess the moral agency and responsibility of AI systems and their creators.
CO4	Demonstrate the use of modern tools in solving ethical issues by exhibiting teamwork through oral presentations and reports
CO5	Evaluate the implications of AI on privacy, surveillance, and data ethics in contemporary society, thereby contributing to life-long learning.

Text Books	
1.	Bartneck, Christoph, Christoph Lütge, Alan Wagner, and Sean Welsh. An introduction to ethics in robotics and AI. Springer Nature, 2021, 1st edition**,** ISBN 978-3-030-51109-8.

2.	Avinash Manure Shaleen Bengani,Saravanan S, Introduction to Responsible AI: Implement Ethical AI Using Python, Apress Media LLC, 2023, 1st edition, ISBN-10 1484299817,ISBN-978-1484299814
3.	Stahl, Bernd Carsten, Doris Schroeder, and Rowena Rodrigues,Ethics of Artificial Intelligence: Case Studies and Options for Addressing Ethical Challenges. Springer Nature, 2023, 1st edition**,** ISBN 978-3-031-17039-3.
4.	Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield, The ethics of Artificial Intelligence: Issues and initiatives,European Parliamentary Research Service, ISBN: 978-92-846-5799-5, doi: 10.2861/6644

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)

#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)

Q.NO.	CONTENTS	MARKS
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 &10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
EXTENDED REALITY **Category: PROFESSIONAL CORE COURSE ELECTIVE-IV (Group-F)** **(Theory)**						
Course Code	**:**	**CD374TFD**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction to AR, VR, and MR: Introduction: Introduction to Virtual Reality (VR)-Augmented Reality (AR)-Mixed Reality (MR); Taxonomy and Classification of AR systems; Differences between AR, VR, and MR; Key features and challenges of AR; Types of AR Systems and their functionality.	
Unit – II	**09 Hrs**
Geometry of Virtual Worlds and Human Vision: Geometric modeling and transformations; Axis-angle representations of rotation; Chaining transformations and viewing transformations; Fundamentals of human visual system; Depth cues, stereopsis, perception in immersive environments.	
Unit –III	**09 Hrs**
Virtual Reality Systems and Design: Introduction, Input and output devices; VR Hardware: Headsets, Controllers, Gloves; VR Software Development Tools; User interface (UI) and user experience (UX) design: Spatial, Interaction, Visual Design in VR; Feedback and Responsiveness in VR Environments.	
Unit –IV	**09 Hrs**
Augmented Reality Systems and Design: Introduction to AR Hardware: AR Glasses, Wearables, Mobile; Types of AR: Marker-based, Markerless, Location-based; AR SDKs and Development Tools; AR Design Principles: Context, Interaction, Physical-Digital Integration.	
Unit –V	**09 Hrs**
Advanced Topics and Future Trends in AR/VR: Augmented Reality and Artificial Intelligence, Computer Vision in AR/VR, Internet of Things (IoT) integrated AR/VR, Mixed Reality, and future trends and innovations in AR/VR/MR. Human factor issues, user performance, sensorial conflict aspects of VR/AR/MR.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Apply the fundamental concepts and design principles of Augmented Reality and Virtual Reality.
CO2	Analyze and make appropriate choice of mathematical foundations, hardware, and software development tools required for VR and AR.
CO3	Design and develop immersive AR/VR experiences by applying principles of user interface design, interaction design, and user experience.
CO4	Analysis of human factor issues, user performance, sensorial conflict aspects of VR/AR/ MR.

Reference Books	
1.	Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley- IEEE Press, 2003/2006, ISBN-13 : 978-0471360896
2.	Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013, ISBN-13 : 978-0240824086.
3.	Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications: Foundations of Effective Design, Morgan Kaufmann, 2009, ISBN: 978-0123749437.
4.	Vladimir Geroimenko, Augmented Reality and Artificial Intelligence: The Fusion of Advanced Technologies, Springer International Publishing AG,2024, ISBN-13 : 978-3031271687
5.	Gitanjali Rahul Shinde, Prashant Shantaram Dhotre, Parikshit Narendra Mahalle, Nilanjan Dey, Internet of Things Integrated Augmented Reality, First edition, Springer Verlag, Singapore 2021, ISBN-13 : 978-9811563737.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
DATA AND STORYTELLING **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**AI375TGA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Understanding Data: Types, Sources, and Preparation: What is data and why it matters, Types of data – qualitative, quantitative, structured, unstructured, 3Vs of big data – volume, velocity, variety, Common data sources – government portals, sensors, APIs, crowd sourced platforms, Data representations – tabular, relational, JSON, XML formats, Introduction to spreadsheets and data frames, Basics of data preprocessing – missing value handling, normalization, type casting, cleaning workflows using Python (pandas) or spreadsheets	
Unit – II	**09 Hrs**
Data Collection for Exploratory Research: Methods of primary data collection – surveys, interviews, FGDs, observations, Designing structured questionnaires and interview guides, Ensuring question clarity, neutrality, and goal alignment, Sampling strategies – random, stratified, purposive sampling, Field planning and respondent communication, Ethical considerations – consent, privacy, data sensitivity, Transcription and textual data cleaning.	
Unit –III	**09 Hrs**
Sensor Data Collection and logging: Introduction to IoT and embedded data logging, Sensor interfacing – temperature, humidity, motion, light sensors, Analog-to-digital conversion and signal conditioning, Sampling rates and real-time clock synchronization, Wireless transmission – BLE, Wi-Fi, LoRa, Local and remote data logging – SD cards, cloud platforms, Handling data quality issues – noise, missing values, power constraints, security and privacy (Man in the middle attacks). Real-time plotting, Visualizing trends, anomalies, and multi-sensor overlays, Debugging and optimizing embedded data pipelines, Mapping Urban Tree Inequality: A Data-Driven Look at Green Access, Building a Local Data Chain to Map Green Equity in Our Cities, Project Pakshi	
Unit –IV	**09 Hrs**
Storytelling through Data: Communicating patterns and trends with clarity, Building simple, reproducible analysis notebooks, Introduction to data storytelling and presentation, Structuring analysis reports – insights, visuals, limitations, Creating visual narratives – dashboards, summaries, infographics, Ethical data interpretation – avoiding bias and misrepresentation	
Unit –V	**09 Hrs**
Statistics Done Wrong: Statistical Significance, Statistical Power, and the Problem of Underpowered Studies, Pseudoreplication, Model Abuse, Researcher Freedom, Hiding the data. Final project – design, collect, visualize, and present data using field instruments, embedded systems, or secondary sources	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand different types, sources, and representations of data, and perform basic preprocessing using modern tools.
CO2	Design and implement primary data collection strategies using surveys, interviews, and sampling techniques with ethical considerations.
CO3	Interface and configure sensors for real-time data logging, transmission, and visualization while addressing data quality and privacy issues.
CO4	Create structured analysis reports and visual narratives to communicate insights clearly and ethically using dashboards and notebooks.

CO5	Identify and critique common statistical errors and misinterpretations in data analysis to promote valid and ethical research practices.

Reference Books	
1.	The Craft of Research, Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams, University of Chicago Press, Fifth Edition, 2024, ISBN-13: 978-0226826677
2.	Sensor Data Analysis and Management: The Role of Deep Learning, Editors: A. Suresh, R. Udendhran, M. S. Irfan Ahmed, Wiley-IEEE Press, 2021, ISBN-13: 978-1119682424
3.	Storytelling with Data: A Data Visualization Guide for Business Professionals, Cole Nussbaumer Knaflic, Wiley Publications, 2015, ISBN-13: 978-1119002253
4.	Statistics Done Wrong: The Woefully Complete Guide, Alex Reinhart, No Starch Press, 2015, ISBN-13: 978-1593276201

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
AIRCRAFT SYSTEMS **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**AS375TGB**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**
Flight Control Systems: History of Airplanes, Anatomy of an aircraft, Anatomy of an aircraft, Primary and secondary flight control surfaces, Flight control linkage system, Conventional Systems, Power assisted and fully powered flight controls, Electronic flight control system-fly by wire system.	
Unit – II	**09 Hrs**
Aircraft Hydraulic & Pneumatic Systems: Components of a typical Hydraulic system, Working or hydraulic system, Power packs, Hydraulic actuators, Pressure regulating devices, Hydraulic pumps, Pneumatic system and components, Use of bleed air, Landing gear and braking,	
Unit –III	**09 Hrs**
Aircraft Fuel Systems: APU, RAT, Characteristics of aircraft fuel system, Fuel system and its components, different types of fuel tanks, types of fuel lines, Fuel pumps-classification, Fuel control unit, Gravity feed and pressure feed fuel systems,	
Unit –IV	**09 Hrs**
Environmental Control Systems: Air-conditioning system, vapour cycle system, deicing 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	**09 Hrs**
Aircraft Instruments: Instruments displays, 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: After completing the course, the students will be able to:	
CO1	Demonstrate a comprehensive understanding of the fundamental components and operational principles of major aircraft systems
CO2	Analyze and explain the functions of various subsystems of aircraft in emphasizing their roles in safe and efficient flight operations
CO3	Apply knowledge of aircraft systems to identify typical issues and malfunctions related to flight controls and other subsystems
CO4	Evaluate the regulatory considerations in aircraft system technologies for different flight envelopes

Reference Books	
1	Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Fundamentals Of Flight Vol 4: Aircraft Systems, Lalit Gupta, Op Sharma, Himalayan Books, ISBN-13: 9788170020974
3	Flight stability and automatic control, Nelson R.C, 2nd Edition, 1998, McGraw-Hill International Editions, ISBN 9780071158381.
4	Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Ian Moir, Allan Seabridge, 3rd Edition, 2008, John Wiley & Sons,. ISBN 978111965006.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY & PRACTISE)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	**20**
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	**16**
3 & 4	Unit 2: Question 3 or 4	**16**
5 & 6	Unit 3: Question 5 or 6	**16**
7 & 8	Unit 4: Question 7 or 8	**16**
9 & 10	Unit 5: Question 9 or 10	**16**
	TOTAL	**100**

Semester: VII					
HEALTHCARE TECHNOLOGY FOR ENGINEERS **Category : Institutional Elective – II (Group G)** **(Theory)**					
Course Code	**:**	**BT375TGC**	**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**	**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45Hrs**	**SEE Duration**	**:**	**3Hours**

Unit-I	**09Hrs**
Introduction to Healthcare Technology: National Digital Health Mission & Healthcare, IT Infrastructure, Telemedicine and remote healthcare applications, Basic Terminology and Role of Engineers in Healthcare Technology; Definition and importance of healthcare technology, Roles and responsibilities of engineers in the healthcare sector, Interdisciplinary collaboration between healthcare professionals and engineers, Key technologies used in modern healthcare systems.	
Unit – II	**09 Hrs**
Healthcare Data Management and Digital Epidemiology: Introduction to healthcare data types (structured, unstructured, real-time data), EHR in healthcare and its applications, Data security and privacy in healthcare, Role of digital epidemiology in tracking and predicting diseases, Use of AI and machine learning in healthcare data analysis.	
Unit –III	**09 Hrs**
Technology-Led Healthcare: Clinical Decision Support Systems (CDSS) and AI in Diagnosis Machine Learning and Deep Learning in Healthcare, Patient Monitoring Systems (PMS) and IoT Applications, Wearable Devices for Health Tracking. **Technology-Led Healthcare:** Quality Management Systems in Healthcare, Infection Prevention and Waste Management Technologies, Medical Device Development and Quality Assurance, Smart Hospitals: Case Study of a Technology-Enabled Hospital.	
Unit –IV	**09 Hrs**
Regulatory, Policy and Cybersecurity Aspects: Legal, Ethical and Intellectual Property Rights in Healthcare Technology, Cybersecurity in Healthcare; Data Protection and Privacy, Health Technology Assessment and Procurement Strategies.	
Unit –V	**09 Hrs**
Innovations in Healthcare Technology: Simulation and Organ Modelling for Medical Applications,3D Printing and Tissue Engineering in Healthcare, Augmented Reality (AR) and Virtual Reality (VR) in Medical Applications, Robotics and Biomechanics in Healthcare, Emerging Digital Health Technologies and Future Trends.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Design, and implement healthcare technologies effectively
CO2:	Analyse the perspective of sensing and imaging in technology for the better health
CO3:	Ensuring compliance with regulatory and cybersecurity frameworks of healthcare data.
CO4:	Evaluate various tools, techniques and advances for better formulation and productivity

Reference Books	
1.	"Biomedical Engineering: Bridging Medicine and Technology." Saltzman, W. Mark., Cambridge University Press, 2015. https://doi.org/10.1017/CBO9781139583831.
2.	"Medical Instrumentation: Application and Design.",Webster, John G., 4th ed., John Wiley & Sons, 2010.
3.	"Artificial Intelligence in Healthcare". Mahajan, Parag., 2nd (General) ed., Updated 2022.
4.	"Healthcare Information Technology Exam Guide for CHTS and CAHIMS Certifications". McCormick, Karen A., Barbara Gugerty, and James E. Mattison., McGraw Hill Professional, 2017.
5.	"Introduction to Biomedical Engineering". Enderle, John D., and Joseph D. Bronzino, editors.,3rd ed., Academic Press, 2012. ISBN: 978-0-12-374979-6.
6.	"Healthcare Information Privacy and Security: Regulatory Compliance and Data Security in the Age of Electronic Health Records". Robichau, Bernard Peter, Apress, 2014.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16

Semester: VII						
Green and Hydrogen Technology **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**CH375TGD**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Hydrogen: Peculiarity and Types Salient features of hydrogen, properties of hydrogen, terminology and types of hydrogen, advantages, disadvantages, comparison with other fuels, and global status of supply and demand.	
Unit – II	**09 Hrs**
Hydrogen Generation Generation of different types of hydrogen, conventional methods (generation from non-renewable sources), nonconventional methods (generation from renewable sources).	
Unit –III	**09 Hrs**
Hydrogen Storage Storage as compressed gas, storage as cryogenic liquid, storage as metal hydrides, storage through liquid organic hydrogen carriers, and other storage methods.	
Unit –IV	**09 Hrs**
Hydrogen Handling and Safety Classification of hydrogen hazards, compressed and liquid hydrogen related hazards, regulation, codes and standards related to hydrogen handling and transport.	
Unit –V	**09 Hrs**
Hydrogen Applications Applications of hydrogen in various sectors such as refineries, petrochemicals, fertilizer industries, transport and automotive sectors, steel industries, and AI in hydrogen technology.	

Course Outcomes	
CO1	Understand the importance of hydrogen and its use as an energy carrier
CO2	Explain the production, storage and handling of hydrogen
CO3	Analyze the need for hydrogen as an alternate fuel and the associated challenges
CO4	Appraise the importance of safety, regulations and codes

Reference Books	
1.	Hydrogen Safety: Production, Transport, Storage, Use, and the Environment, Fotis Rigas, CRC Press, Taylor & Francis Group, 2nd Edition, 2023, ISBN: 9781003313007
2.	Hydrogen Fuel: Production, Transport and Storage, Gupta, R. B., CRC Press, Taylor & Francis Group, 1st Edition, 2009, ISBN: 9780429147364
2.	Hydrogen Production: Electrolysis, Agata Godula-Jopek, Wiley-VCH, 1st Edition, 2015, ISBN:9783527333424
3.	Handbook of Hydrogen Storage, Michael Hirscher, Wiley-VCH, 1st Edition, 2010, ISBN:9783527322732
4.	Fuel Cell Systems Explained, James Larminie and Andrew Dicks, John Wiley & Sons, 2nd Edition, 2003, ISBN 978 0470 848579

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester : VII				
CHEMISTRY OF MATERIALS AND MOLECULAR ANALYSIS **Category : Institutional Elective – II (Group G)** **(Theory)**				
Course Code	**CM375TGE**		**CIE Marks**	**100**
Hrs/Week	**L: T: P: EL: 3:0:0:0**		**SEE Marks**	**100**
Credits	**03**		**SEE duration**	**03**

UNIT – I	
Advanced Materials for Smart Packaging: Biodegradable polymers, Bio-polymers, Nanomaterials, and Active packaging materials-Self-healing films, antimicrobial coatings and moisture-sensitive barriers for food and pharmaceutical industries. Thermal-responsive packaging used in food safety, drug stability and electronics protection.	**09 Hrs**
UNIT – II	
Innovations in Computational Chemistry: Introduction to ChemDraw and its Interface- basic to advanced functionalities for chemical drawing, reaction representation, and integration with computational tools. Cheminformatics and molecular screening. -molecular modeling and simulation techniques- molecular docking, virtual screening, and quantitative structure-activity relationships (QSAR)- generative AI for novel drug molecules- neural networks for toxicity prediction and AI-assisted biomolecular structure prediction.	**09 Hrs**
UNIT – III	
IR Spectroscopy: Introduction, principle, molecular vibrations, vibrational frequency, number of fundamental vibrations, factors influencing fundamental vibrations, instrumentation of IR spectrophotometer, application of IR spectroscopy in characterization of functional groups- IR spectroscopy in forensic science, pharmaceuticals, environmental monitoring and material characterization.	**09 Hrs**
UNIT – IV	
UV- visible Spectroscopy: Introduction-Electronic transitions- factors influencing position and intensity of absorption bands-absorption spectra of dienes, polyene and α, β-unsaturated carbonyl compounds, Bandgap calculations utilizing UV. Working of UV-Vis spectrophotometer. AI-driven spectral analysis, and computational approaches for UV-Vis data interpretation. UV-Vis spectroscopy in nanomaterials and biomedical applications.	**09 Hrs**
UNIT – V	
NMR spectroscopy: H^1 NMR Spectroscopy: Basic concepts- relaxation process. NMR spectrometer-FT NMR-Solvents used in NMR, internal standards-chemical equivalence - chemical shift-Factors affecting chemical shifts- shielding and deshielding effects – chemical and magnetic equivalent –magnetic anisotropy-spin-spin splitting rules- Application of NMR on in characterization of compounds- magnetic resonance imaging (MRI)-Bio-Engineering-Bio-Imaging. Problems on prediction of structure of compounds. Basics of Solid State NMR.	**09 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Apply the principles of chemistry for the synthesis of smart packaging materials, cheminformatics, drug discovery and materials analysis.
CO2:	Utilize the knowledge of chemistry, AI-driven molecular modelling and spectral analysis to identify compounds and predict toxicity.
CO3:	Analyse IR, UV-Vis, and NMR spectroscopic data for material characterization and biomolecular studies.
CO4:	Propose smart packaging solutions and AI-assisted molecular screening methods for biomedical and pharmaceutical applications

Reference Books	
1.	*"Introduction to Spectroscopy"* by Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James A. Vyvyan, Published by Cengage Learning, 5th edition, ISBN- 978-1285460123
2.	"*Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics*" – Errol G. Lewars. Published by Springer 2024, 4th edition, ISBN- 978-3031514425
3.	*"Handbook of Materials Structures, Properties, Processing and Performance"* by Lawrence E. Murr Published by Springer, ISBN- 978-3319018140.
4.	"*Handbook of Biodegradable Polymers-Applications in Biomedical Sciences, Industry, and the Environment*" by Shakeel Ahmed and Riyaz Ali Osmani Published by Jenny Standford Publishing 2024, ISBN -9789814968843
5.	*"An Introduction to Chemoinformatics"* by Andrew R. Leach and Valerie J. Gillet, published by Springer ISBN 978-1402062902.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
CHEMISTRY OF MATERIALS AND MOLECULAR ANALYSIS **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**CM375TGE**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hrs	**:**	**45L**		**SEE duration**	**:**	**03**

UNIT – I	**09 Hrs**
Advanced Materials for Smart Packaging: Biodegradable polymers, Bio-polymers, Nanomaterials, and Active packaging materials-Self-healing films, antimicrobial coatings and moisture-sensitive barriers for food and pharmaceutical industries. Thermal-responsive packaging used in food safety, drug stability and electronics protection.	
UNIT – II	**09 Hrs**
Innovations in Computational Chemistry: Introduction to ChemDraw and its Interface- basic to advanced functionalities for chemical drawing, reaction representation, and integration with computational tools. Cheminformatics and molecular screening. -molecular modeling and simulation techniques- molecular docking, virtual screening, and quantitative structure-activity relationships (QSAR)- generative AI for novel drug molecules-neural networks for toxicity prediction and AI-assisted biomolecular structure prediction.	
UNIT – III	**09 Hrs**
IR Spectroscopy: Introduction, principle, molecular vibrations, vibrational frequency, number of fundamental vibrations, factors influencing fundamental vibrations, instrumentation of IR spectrophotometer, application of IR spectroscopy in characterization of functional groups- IR spectroscopy in forensic science, pharmaceuticals, environmental monitoring and material characterization.	
UNIT – IV	**09 Hrs**
UV- visible Spectroscopy: Introduction-Electronic transitions- factors influencing position and intensity of absorption bands-absorption spectra of dienes, polyene and α, β-unsaturated carbonyl compounds, Bandgap calculations utilizing UV. Working of UV-Vis spectrophotometer. AI-driven spectral analysis, and computational approaches for UV-Vis data interpretation. UV-Vis spectroscopy in nanomaterials and biomedical applications.	
UNIT – V	**09 Hrs**
NMR spectroscopy: H^1 NMR Spectroscopy: Basic concepts- relaxation process. NMR spectrometer-FT NMR-Solvents used in NMR, internal standards-chemical equivalence - chemical shift-Factors affecting chemical shifts-shielding and deshielding effects – chemical and magnetic equivalent –magnetic anisotropy-spin-spin splitting rules-Application of NMR on in characterization of compounds- magnetic resonance imaging (MRI)-Bio-Engineering-Bio-Imaging. Problems on prediction of structure of compounds. Basics of Solid-State NMR.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Apply the principles of chemistry for the synthesis of smart packaging materials, cheminformatics, drug discovery and materials analysis.
CO2:	Utilize the knowledge of chemistry, AI-driven molecular modelling and spectral analysis to identify compounds and predict toxicity.

CO3:	Analyse IR, UV-Vis, and NMR spectroscopic data for material characterization and biomolecular studies.
CO4:	Propose smart packaging solutions and AI-assisted molecular screening methods for biomedical and pharmaceutical applications

Reference Books	
1.	*"Introduction to Spectroscopy"* by Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James A. Vyvyan, Published by Cengage Learning, 5th edition, ISBN- 978-1285460123
2.	**"***Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics*" **–** Errol G. Lewars. Published by Springer 2024, 4th edition, ISBN- 978-3031514425
3.	*"Handbook of Materials Structures, Properties, Processing and Performance"* by Lawrence E. Murr Published by Springer, ISBN- 978-3319018140.
4.	"*Handbook of Biodegradable Polymers-Applications in Biomedical Sciences, Industry, and the Environment*" by Shakeel Ahmed and Riyaz Ali Osmani Published by Jenny Standford Publishing 2024, ISBN -9789814968843
5.	*"An Introduction to Chemoinformatics"* by Andrew R. Leach and Valerie J. Gillet, published by Springer ISBN 978-1402062902.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	COMPONENTS	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
PART A		
1	Objective type questions covering entire syllabus	20
PART B (Maximum of THREE Sub-divisions only)		
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16

Semester: VII						
PROMPT ENGINEERING **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**CS375TGF**		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	100 Marks
Total Hours	**:**	**40 L**		**SEE Duration**	**:**	03 Hours

Unit-I	**8 Hrs**
Introduction to Prompt Engineering: Raise of Context Learning, Prompts, Prompt Engineering, LLM Settings, Basic Prompt/ Basics of prompting, Elements of a Prompt, Settings for Prompting Language Model/ General Tips for Designing Prompts, Designing Prompts for Different Tasks: few examples of common tasks using different prompts Text Summarization, Information Extraction, Question Answering, Text Classification, Conversation/Role Playing, Code Generation, Reasoning	
Unit – II	**8 Hrs**
Techniques for Effective Prompts: Techniques designed to improve performance on complex tasks - Zero-Shot Prompting, Few-shot prompting, Chain-of-thought (CoT) prompting, Zero-Shot CoT, Self-Consistency, Knowledge Generation Prompting, Program-aided Language Model (PAL), React, Directional Stimulus Prompting **Prompt Tuning vs. Fine-Tuning:** Introduction and Types for Tuning, Tools & Libraries for Tuning-Hugging Face PEFT library (Parameter-Efficient Fine-Tuning), Trade-off decisions: when to prompt-tune vs. fine-tune	
Unit –III	**8 Hrs**
Best Practices in Prompt Engineering Tools & IDEs: Capabilities include: Developing and experimenting with prompts, Evaluating prompts. Versioning and deploying prompts; Advanced prompting techniques: advanced applications with LLMs **LLMs and external tools/APIs** -- LLMs with External Tools; Data-augmented Generation – Steps, External Data, QA with sources, Summarization using sources **Prompt Debugging & Interpretability Tools:** Importance of interpretability in LLMs- Visualization tools- LIT (Language Interpretability Tool by Google) - OpenAI Playground, debug tools	
Unit –IV	**8 Hrs**
Applications of Prompt Engineering: LLM Applications: Function Calling with LLMs - Getting Started with Function Calling, Function Calling with GPT-4, Function Calling with Open-Source LLMs. **Function Calling Use Cases**: Conversational Agents, Natural Language Understanding, Math Problem Solving, API Integration, Information Extraction	
Unit –V	**8 Hrs**
Ethics in AI-Generated Content: Introduction to AI Ethics in Generation, Key Ethical Concerns in Prompting-Bias and Discrimination, Misinformation and Hallucination. **Opportunities:** Model safety, Prompt Injection, Prompt Leaking, Jail Breaking; Reinforcement Learning from Human Feedback (RLHF)	

Course Outcomes: After completing the course, the students will be able to	
CO1	Demonstrate an understanding of prompt engineering principles including how prompt structure and phrasing impact the performance of AI models.

CO2	Design and implement effective prompts- to create and apply prompts for various natural language processing (NLP) tasks, such as text generation, summarization, and translation, using AI models.
CO3	Critically evaluate the effectiveness of prompts - assess the quality and performance of prompts in terms of accuracy, coherence, and relevance, identifying areas for improvement.
CO4	Apply prompt engineering techniques in real-world scenarios - use prompt engineering strategies to address practical problems in domains such as education, healthcare, and business, demonstrating the applicability of AI-driven solutions.

Reference Books	
1	Unlocking the Secrets of Prompt Engineering, Gilbert Mizrahi, Jan 2024, 1st Edition, Packt Publishing, ISBN-13:978-1835083833
2	Prompt Engineering for Generative AI, James Phoenix, Mike Taylor, May 2024, O'Reilly Media, Inc. ISBN: 9781098153434
3	Prompt Engineering for LLMs, John Berryman, Albert Ziegler, O'Reilly Media, Inc. January 2025, ISBN: 9781098156152
4	**OpenAI Cookbook**-https://github.com/openai/openai-cookbook **"Ethics of Artificial Intelligence and Robotics"** – Stanford Encyclopedia of Philosophy-https://plato.stanford.edu/entries/ethics-ai/
5	**"The Art of Prompt Engineering with OpenAI API" by Nathan Hunter** *(Beginner-friendly, focused on real-world use and debugging)* ISBN: 9798389421630

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII

SOLID WASTE MANAGEMENT AND STATUTORY RULES
Category : Institutional Elective – II (Group G)
(Theory)

Course Code		**CV375TGG**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**10 Hrs**

Introduction: Present solid waste disposal methods. Merits and demerits of open dumping, incineration, pyrolysis, composting, sanitary landfill, Biogas Scope and importance of scientific solid waste management. Definition and functional elements of solid waste management.

Sources: Sources of Solid waste, types of solid waste, composition of municipal solid waste, generation rate, Numerical Problems.

Collection and transportation of municipal solid waste: Collection of solid waste- services and systems, Municipal Solid waste (Management and Handling) 2016 rules with amendments. Draft SWM 2024 rules. Site visit to collection system.

Unit – II	**08 Hrs**

Composting Aerobic and anaerobic composting - process description, process microbiology, Vermicomposting, Site visit to compost plant, Numerical problems.

Sanitary land filling: Definition, advantages and disadvantages, site selection, methods, reaction occurring in landfill- Gas and Leachate movement, Control of gas and leachate movement, Site visit to landfill site.

Unit –III	**08 Hrs**

Hazardous waste management: Definitions, Identification of hazardous waste, Classification of hazardous waste, onsite storage, collection, transfer and transport, processing, disposal, Hazardous and other wastes (Management and Transboundary Movement) Rules, 2016 with amendments. Hazardous and other wastes (Management and Transboundary Movement) amendment rules, 2024. Site visit to hazardous landfill site

Unit –IV	**08 Hrs**

Bio medical waste management: Classification of bio medical waste, collection, transportation, disposal of bio medical waste, Biomedical waste management (Management & Handling Rules) 2016 with amendments. Site visit to hospital to observe biomedical waste collection and transportation system and visit to biomedical waste incineration plant.

Unit –V	**08 Hrs**

E-waste management: Definition, Components, Materials used in manufacturing electronic goads, Recycling and recovery integrated approach. E-waste (Management) Rules 2022 and amendments. Site visit to e- waste treatment plant.

Plastic waste management: Manufacturing of plastic with norms. Plastic waste management. Plastic waste management rules 2016 with amendments.

Course Outcomes: After Completing the course, student will be able to,	
CO1	Understand the current solid waste management system and statutory rules.
CO2	Analyze drawbacks in the present system and provide recycling and disposal options for each type of waste in compliance to rules.
CO3	Distinguish Hazardous waste, Biomedical waste, E waste and to provide scientific management system.
CO4	Evaluate and monitor the Biomedical waste, Hazardous waste, E waste, Plastic and Municipal waste management as per the rules laid by Ministry of Environment, Forest and Climate change.

Reference Books	
1.	Integrated Solid Waste Management, George.C.Tchobanoglous, International edition 2022, McGraw hill publication. ISBN 978-0070632370
2.	Electronic waste management, R.E. Hester, Roy M Harrison, , Cambridge, UK, 2009, RSC Publication, ISBN 9780854041121
3.	Solid Waste Management Rules 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 8th April 2016
4.	Hazardous and other wastes (Management and Transboundary Movement) Rules, 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 04th April, 2016.
5.	Biomedical waste management (Management & Handling Rules) 2016, Ministry of Environment & Forest Notification, New Delhi, amendment on 28th March, 2016.
6.	E-waste (Management) Rules 2022 and amendments, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 2nd November, 2022.
7.	Plastic waste management rules 2016 with amendments., Ministry of Environment, Forest and Climate Change Notification, New Delhi, 6th July 2022.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
Freight Transportation Systems and Logistics Planning **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**CV375TGH**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**08 Hrs**
Characteristics of Freight Transport: Freight Characteristics, Factors influencing Freight Travel, operators, problems in freight transportation, regional and urban goods travel, intermodal freight travel issues, passenger and freight demand models.	
Unit – II	**09 Hrs**
Freight Demand Estimation: Operations, Planning - purpose, process, Data, Freight Agents, costs, Planning Models and Methods-freight demand estimation and forecasting at the regional and urban level, Freight Generation and Freight Trip Generation, Trend and time series models, freight trip rate models, IO model	
Unit –III	**08 Hrs**
Freight Transport Planning and Operations: Freight supply – capacity issues; freight productivity and performance; distribution of freight flows; production/consumption to origin/destination, competing modes for specific commodity choice, route planning, scheduling, collection storage, distribution centres, regulation, and enforcement of freight transport.	
Unit –IV	**09 Hrs**
Logistics and Planning Strategies: Context of Logistics- Activities of Logistics, Aims of Logistics, Importance of Logistics, Current Trends in Logistics; Logistics Strategy- Strategic Decisions, Logistics Strategy, designing a Logistics Strategy; Locating Facilities- Importance of Location, Choosing the Geographic Region, Infinite Set Approaches, Feasible Set Approaches, Network Models, Location Planning; Planning Resources- Types of Planning, Capacity Planning, Adjusting Capacity, Tactical Planning, Schedules	
Unit –V	**08 Hrs**
Emerging Trends and Case Studies in Transportation Logistics: Sustainable and Green Logistics, Digital Transformation in Logistics-IoT, big data analytics, AI, and blockchain in logistics management. **Case Studies and Real-World Applications:** Case studies on logistics and transportation from various sectors. Analysis of successful logistics systems and lessons learned.	

Course Outcomes	
CO1	Explain the characteristics, components, and current trends in freight transportation and logistics
CO2	Analyze and apply freight demand estimation methods and logistics planning strategies for urban and regional transport systems
CO3	Evaluate freight transport systems and logistics networks with respect to performance, capacity, sustainability, and regulation
CO4	Design integrated freight and logistics solutions using data-driven models, technology, and strategic planning approaches

Reference Books	
1	M. Ben-Akiva, H. Meersman, and E. V. de Voorde, "Freight Transport Modelling" Bingley, U.K.: Emerald Group Publishing, ISBN-13: 9781781902851,2013.
2	P. K. Sarkar, V. Maitri, and G. J. Joshi, "Transportation Planning: Principles, Practices and Policies", 3rd ed. New Delhi, India: PHI Learning, ISBN : 9788195161188, 2024
3	L. Tavasszy and G. de Jong, "Modelling Freight Transport". 1st ed. Amsterdam, Netherlands: Elsevier, ISBN-13: 9780124104006,2013.
4	M. Al-Azzawi, "Freight and Logistics Transport Modelling and Planning: Mathematical Theories and Practical Applications for the Analysis and Forecasting of Freight Transport Systems". Saarbrücken, Germany: LAP Lambert Academic Publishing, ISBN-13: 9783848428380,2012

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
IoT FOR SMART SYSTEMS **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**EC375TGI**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction to IoT and Networking Basics IoT Architecture Layers (Perception, Network, Application), Overview of Networking Basics: TCP/IP, OSI Model, Wireless Concepts, Device Addressing: IPv4, IPv6, 6LoWPAN, IoT orchestration primitives, IoT Open-Source platforms.	
Unit – II	**09 Hrs**
IoT Communication Models and Protocols **Smart Manufacturing**-OPC-UA interfacing, Deterministic Ethernet & Time Sensitive Network, PLC gateways, MQTT-Sparkplug B, Predictive maintenance dashboard design with AI-based Optimization. **Smart Construction Site:** MQTT with QoS for equipment-telemetry and asset tracking, Edge gateway (rugged fog node) with aggregating sensor feeds (On-site construction).	
Unit –III	**09 Hrs**
IoT Networking Technologies **Smart Healthcare**: IEEE 802.15.6 BLE Body Area Networks, NFC for patient data access and device pairing, HL7 and FHIR standards for health data exchange. **Smart Mobility**: Next-gen V2X, LTE-M for roadside units and environmental sensors, Edge-cloud split for traffic-signal optimization, LPWAN & NB-IoT with link-budget exercise.	
Unit –IV	**09 Hrs**
IoT Software Stack **Smart Agriculture Systems:** Device Layer: Sensor nodes run on MCUs with firmware enabling periodic sensing, sleep scheduling, and uplink messaging over LPWAN. Network Layer: Embedded Operating Systems for IoT (Free RTOS). Middleware Layer: Gateway running rule engine and device management, Device abstraction and Service Enablement, Secure bootloaders for wireless firmware updates in remote farms. Application Layer: Web/mobile dashboard for farmers with real-time alerts and analytics, Things Board for drag-and-drop rule engine.	
Unit –V	**09 Hrs**
Interoperability and Standardization in Practice: Challenges of integrating multi-vendor IoT devices, Interoperability issues in AI-Enabled IoT Deployments, Data Semantics & Model Portability, AI Bias & Fairness Across Domains, Security of AI pipelines, GDPR compliance & data retention policies in IoT platforms**.**	

Course Outcomes	
CO1	Develop a conceptual framework of IoT architectural layers and connectivity models.
CO2	Analyze IoT-specific communication models, protocols, and networking technologies.
CO3	Apply AI techniques for IoT communication optimization and network intelligence.
CO4	Evaluate secure, energy-efficient IoT networks with intelligent features.

Reference Books	
1.	Internet of Things: Principles and Paradigms, Rajkumar Buyya, Amir Vahid Dastjerdi, Morgan Kaufmann Publishers, 2nd Edition, 2024, ISBN: 978-0-323-99167-2
2.	Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Florian Michahelles Springer, 2nd Edition, 2023 ISBN: 978-3-031-10318-4
3.	IoT Applications for Next-Generation Smart Systems, D. Giusto et al., Springer,2024, ISBN:978-1-799-87541-3
4.	Artificial Intelligence for the Internet of Everything, William Lawless, Ranjeev Mittu, Donald Sofge Academic Press, 2023 ISBN: 978-0-12-820600-1

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
E-MOBILITY **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**EE375TGJ**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
History, Basics of Electric Vehicles, Components of Electric Vehicle, General Layout of EV, EV classification: Battery Electric Vehicles (BEVs), Hybrid Electric Vehicle (HEV), Fuel-Cell Electric Vehicles (FCEVs) Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EV, National Policy for adoption of EVs.	
Unit – II	**09 Hrs**
Electric Drive-Trains: Introduction to various electric drive-train topologies in EV and HEV, Power flow control in electric drive-train topologies, classification of electric machines used in automobile drivetrains. **E-Motor Drives Configuration (Control Block diagrams):** Induction Motor Drive, Permanent Magnet (PM) motor Drive & Switched Reluctance Motor (SRM) Drive.	
Unit –III	**09 Hrs**
Battery Energy Storage: Types of Battery, Introduction to Electrochemical Battery, Electrochemical Reactions, Battery Parameters: Battery Capacity, Discharge Rate, Charging Rate, SOC, SOD, SOH, DOD, Specific Energy, Specific Power, Energy Efficiency. **Battery Management Systems (BMS):** Introduction to BMS, Objectives of the BMS: Discharging control, Charging control, Cell Balancing; BMS topologies: Distributed Topology, Modular Topology and Centralized Topology.	
Unit –IV	**09 Hrs**
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage, Fuel Cell based energy storage, Super Capacitor based energy storage, Hybridization of different energy storage devices. Introduction to BMS and its topologies. **Energy Management Strategies**: Introduction to energy management strategies used in hybrid and electric vehicles, Classification of different energy management strategies, Comparison of different energy management strategies and implementation issues of energy management strategies.	
Unit –V	**09 Hrs**
Charging Infrastructure: Basic Requirements for Charging System, Charger Architectures, Grid Voltages, Frequencies, and Wiring, Charging Standards and Technologies, SAE J1772. On-board chargers and Off-board chargers, Topologies and Standards, Types of Charging Station Charging Station Placement for Electric Vehicles: A Case Study.	

Course Outcomes	
CO1	Analyze the basics of electric and hybrid electric vehicles, their architecture, technologies and modelling.
CO2	Analyze various electric drives suitable for electric vehicles.
CO3	Discuss and implement different energy storage technologies used for electric vehicles and their management system.
CO4	Analyze various charging methods, requirements, standards and types of charging for EV and HEV.

Reference Books	
1.	Modern Electric Vehicle Technology C.C. Chan and K.T. Chau, 1st Edition, 2001, Oxford university press, ISBN 0198504160.
2.	Battery Management system for large Lithium Battery Packs, Davide Andrea, 1st Edition, 2010, ARTECH HOUSE, ISBN-13 978-1-60807-104-3.
3.	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.
4.	Hybrid Vehicles from Components to System, F. BADIN, Ed, 1st Edition, 2013, Editions Technip, Paris, ISBN 978-2-7108-0994-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
DISEASE AND DIAGNOSTICS AN ENGINEERING PERSPECTIVE **Category : Institutional Electives -II (Group G)** **(Theory)**						
Course Code	**:**	**EI375TGK**		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	**03:00:00**		**SEE**	**:**	100 Marks
Total Hours	**:**	**45L**		**SEE Duration**	**:**	03 Hrs

Unit-I	**09 Hrs**
Cardiovascular System (CVS) - Functioning of CVS, Generation of Bio-Potentials of CVS, Common cardiovascular ailments. - Arrhythmias, Hypertension, Coronary vascular Diseases, Diagnostic devices- ECG, ECHO. Coronary Angiogram. Implantable devices: Pacemaker.	
Unit – II	**09 Hrs**
Respiratory System (RS) - Functioning of RS, Common ailments in RS, Lung volume and capacity, Diagnostic Devices- Spirometer and its recent advances, PPG Signals and its application in RS.	
Unit –III	**09 Hrs**
Renal System - Functioning of Renal System, Common diseases of Renal System, Diagnostics- Ultrasound and its application in Renal System. Therapeutic- Dialysis and its types. Bio-Markers in Renal System, Emerging dialysis technologies: Wearable artificial kidney.	
Unit –IV	**09 Hrs**
Central Nervous System (CNS) - Basics of CNS functioning, Common ailments, Diagnostics methods-EEG, Electrode Systems, Role of CT scans and MRI. Brain-Computer Interfaces (BCI): Basic concepts and diagnostic/therapeutic potential.	
Unit –V	**09 Hrs**
Introduction to Artificial Intelligence (AI) in Healthcare - Overview of AI, Machine Learning, Deep Learning, Need for AI in healthcare, Types of data in healthcare: structured, unstructured., Challenges of AI deployment: Data bias, privacy, and integration in clinical workflow.	

Course Outcomes	
CO1	**Understand** the basic functioning and common disorders of cardiovascular, respiratory, renal, and nervous systems.
CO2	**Understand the** working principles and clinical relevance of diagnostic devices such as ECG, EEG, spirometer, ultrasound, and imaging systems.
CO3	**Analyze** biomedical signals and interpret their significance in the diagnosis and monitoring of diseases.
CO4	**Evaluate** the potential and limitations of emerging technologies such as wearable devices, Brain-Computer Interfaces, and AI in healthcare applications.

Reference Books	
1.	Handbook of Biomedical Instrumentation, R. S. Khandpur,3rd Edition, Reprint 2016, Tata McGraw-Hill, ISBN: 9780070473553.
2.	Biomedical Instrumentation and Measurements, Leslie Cromwell & others, 2nd Edition, Reprint 2015, ISBN: 9780130771315.
3.	Introduction to Biomedical Equipment Technology, Joseph J. Carr and John M. Brown, 4th Edition, 2000, Pearson, ISBN:978-0130104922**.**
4.	Medical Instrumentation Application and Design, John G. Webster ,4th Edition,2010, ISBN 13: 978- 0471-67600-3.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
Space Technology and Applications **Category : Institutional Elective (Group-G)** **(Theory)**						
Course Code	**:**	**ET375TGL**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hours**

UNIT – I	**9 Hours**
Orbits and Launching Methods: Kepler's Laws, Orbital Elements and Perturbations, Inclined Orbits Antenna Look Angles, Earth Eclipse of Satellite, Sun Transit Outage. **Launch Vehicles:** Rocketry, Propellants, Propulsion, Combustion, Solid, Liquid and Cryogenic engines, Control and Guidance system, Ion propulsion and Nuclear Propulsion.	
UNIT – II	**9 Hours**
Satellite Sub-Systems: Classification of satellites., Payloads, Subsystems-Altitude and orbit control system, TT&C Sub-System, Power Systems. **Communication sub systems:** Transponder, Satellite antennas and Parameters, Satellite Antennas in Practice	
UNIT – III	**8 Hours**
Satellite Communications: LEO, MEO and GEO orbits, Multiple Access Techniques. -TDMA, FDMA and CDMA **Space applications:** Telephony, V-SAT, DBS system, Satellite Radio and TV, Tele-Education, Tele-medicine, Satellite navigation, GPS	
UNIT – IV	**8 Hours**
Remote Sensing: Remote Sensing – An Overview, Classification of Satellite Remote Sensing Systems, Remote Sensing Satellite Payloads, Sensor Parameters. Image processing techniques, Remote sensing cameras. **Applications of Remote Sensing Satellites**: - Land Cover Classification, Land Cover Change Detection Water Quality Monitoring and Management, Flood Monitoring, weather modelling, Cyclone predictions, Disaster and flood warning, rainfall predictions using satellites.	
UNIT – V	**8 Hours**
Space Missions: Technology missions, deep space planetary missions, Lunar missions, zero gravity experiments, space biology and international space Missions. **Advanced space systems:** planetary payloads, space shuttle, space station, Inter-space communication systems.	

Course Outcomes: After going through this course the student will be able to:		
CO1	:	Explore the different types of satellites, their orbital mechanics and associated subsystems.
CO2	:	Apply the basics of launching vehicles, satellites and sub systems for space applications.
CO3	:	Identify the applications of satellite in the Various areas such as communication, remote sensing, metrology etc.
CO4	:	Analyze the technology trends, satellite missions and advanced space systems.

Reference Books	
1.	Satellite Communications, Dennis Roddy, W. Linwood Jones, Jones Linwood, David G. Long, 5ed, McGraw Hill Education,2024, ISBN-10: 1265372543
2.	Fundamentals of Satellite Communication, K N Raja Rao, PHI, 2012, ISBN: 9788120324015.
3.	Satellite Communication, Timothy Pratt, John Wiley, 3ed,2019, ISBN: 978-1-119-48217-8
4.	Remote sensing and applications, B C Panda, VIVA books Pvt. Ltd., 2009, ISBN: 108176496308.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRICS FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: Question 2	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	MAXIMUM MARKS FOR THE SEE	**100**

Semester: VII						
PROJECT MANAGEMENT **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**IM375TGM**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction: Project, Project management, relationships among portfolio management, program management, project management, and organizational project management, relationship between project management, operations management and organizational strategy, business value, role of the project manager, project management body of knowledge. **Generation and Screening of Project Ideas:** Generation of ideas, monitoring the environment, corporate appraisal, scouting for project ideas, preliminary screening, project rating index, sources of positive net present value.	
Unit – II	**09 Hrs**
Project Scope Management: Project scope management, collect requirements define scope, create Work Breakdown Structure, validate scope, control scope. **Organizational influences & Project life cycle**: Organizational influences on project management, project state holders & governance, project team, project life cycle.	
Unit –III	**09 Hrs**
Project Integration Management: Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase. **Project Quality management:** Plan quality management, perform quality assurance, control quality.	
Unit –IV	**09 Hrs**
Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk. **Project Scheduling:** Project implementation scheduling, Effective time management, Different scheduling techniques, Resources allocation method, Project life cycle management concepts. Project life cycle costing.	
Unit –V	**09 Hrs**
Latest Trends and Open-Source Tools in Project Management: Agile and Hybrid Project Management Approaches, Digital Transformation in Project Management, Sustainability and ESG in Project Management, Overview and Classification of PM Software, Introduction and Demonstration of Key Open-Source Tools.	

Course Outcomes	
CO1	Understand the fundamental concepts of project management and its relationship with organizational strategy, operations management, and business value.
CO2	Apply techniques for generating, screening, and evaluating project ideas, considering factors such as net present value and project rating index.
CO3	Create Work Breakdown Structures (WBS), utilization of PERT/CPM for developing project schedule, alongside requirement collection, scope definition, scope validation, and scope control.
CO4	Develop skills in project integration, quality, risk management, and scheduling, enabling effective project planning, execution, monitoring, and control.

Reference Books	
1.	Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, 2013, ISBN: 978-1-935589-67-9
2.	Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
3.	Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 7th Edition, 2010, ISBN 0-07-007793-2.
4.	Rory Burke, "Project Management – Planning and Controlling Techniques", John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRICS FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
GLOBAL SUPPLY CHAIN MANAGEMENT **Category: Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**IM375TGN**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

UNIT-I	**09 Hrs**
Building a Strategic Frame Work to Analyze Supply Chains: Definition and Objective of Supply Chain, the importance of Supply Chain Decisions, Decision Phases in a Supply Chain, Process View of Supply Chains. Competitive and Supply Chain Strategies, Achieving Strategic fit, Expanding Strategic Scope. Drivers of Supply Chain Performance, Frame work for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing, Infrastructure, International Logistics.	
UNIT – II	**09Hrs**
Designing The Supply Chain Network: The Role of Distribution in the Supply Chains, Factors influencing Distribution Network design, Design Options for a Distribution Network, Online sales and the Distribution network, Distribution Networks in practice. Factors influencing network design decisions, Framework for Network design decisions, The impact of Globalization on Supply Chain networks. **Designing And Planning Transportation Networks:** The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation, The role of IT in transportation, **Problems.**	
UNIT –III	**09Hrs**
Planning and Managing Inventories in a Supply Chain: The Role of Cycle inventory in a Supply Chain, Economies of Scale to Exploit Fixed costs, Managing Multi-echelon Cycle Inventory. The Role of Safety Inventory in a Supply Chain, Determining appropriate level of Safety inventory, Impact of supply Uncertainty on Safety inventory, Impact of aggregation on safety inventory, impact of replenishment policies on safety inventory, Managing Safety Inventory in a Multi-echelon Supply Chain, The Role of IT in inventory management. **Problems**	
Unit –IV	**09Hrs**
Sourcing Decisions in A Supply Chain: The role of sourcing in a supply chain, in-house or outsource, Third-and Fourth-party logistics providers, Total cost of Ownership, Supplier Selection-Auctions and Negotiations, Sharing Risk and Reward in the Supply chain, Ethical Sourcing. **Pricing and Revenue management in Supply Chain**: The role of pricing and revenue management in supply chain, pricing and revenue management for multiple customer segments, pricing and revenue management for perishable assets, pricing and revenue management for seasonal demand and role of IT in pricing and revenue management.	
UNIT –V	**09 Hrs**
Digital Supply Chain: The role of IT in a supply chain, the supply chain IT framework, the supply chain macro processes, Lack of Supply Chain co-ordination and the Bullwhip effect, managerial levers to achieve coordination, continuous replenishment and vendor-managed inventories, collaborative planning, forecasting and replenishment (CPFR).	

Course Outcomes	
CO1	Understand supply chain concepts, systemic and strategic role of SCM in global competitive environment.
CO2	Evaluate alternative supply and distribution network structures using optimization models.
CO3	Develop optimal sourcing and inventory policies in the supply chain context.
CO4	Select appropriate information technology frameworks for managing supply chain processes.

Reference Books	
1	Supply Chain Management – Strategy, Planning & Operation, Sunil Chopra, Peter Meindl & D V Kalra, 6th Edition, 2016, Pearson Education Asia; ISBN: 978-0-13-274395-2.
2	Supply Chain Management – Creating Linkages for Faster Business Turnaround, Sarika Kulkarni & Ashok Sharma, 1st Edition, 2004, TATA Mc Graw Hill, ISBN: 0-07-058135–5
3	Designing & Managing the Supply Chain – Concepts Strategies and Case Studies, David Simchi Levi, Philip Kaminsky, Edith Simchi Levi & Ravi Shankar, 3rd Edition, 2008, Mc Graw Hill, ISBN: 978- 0-07-066698-6
4	Modelling the Supply Chain, Jeremy F Shapiro, 2nd Edition, 2009, Cengage Learning, ISBN 0-495-12609-8.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII

STATISTICAL METHODS FOR ENGINEERS
Category: Institutional Elective – II (Group G)
(Theory)

Course Code	**:**	**MA375TGO**		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I — **09 Hrs**

Multiple Linear Regression:

Introduction to multiple linear regression model, Least squares estimation of the parameters, Matrix approach to multiple linear regression, Properties of the least squares estimators, Hypothesis tests -Test for significance of regression, Tests on individual regression coefficients, Confidence intervals - Confidence intervals on individual regression coefficients, Confidence interval on the mean response, Polynomial regression models.

Unit – II — **09 Hrs**

Design and Analysis of Single-Factor Experiments:

Designing Engineering Experiments, Completely Randomized Single-Factor Experiment, Analysis of Variance (ANOVA), Multiple Comparisons following the ANOVA, Residual analysis and model checking, The random-effects model, Randomized complete block design - design and statistical Analysis

Design of Experiments with Several Factors:

Introduction, Factorial experiments, Two-factor factorial experiments, one observation per cell, General factorial experiments - 2^k Factorial designs, 2^2 Design, 2^k Design for $k \geq 3$ factors.

Unit –III — **09 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.

Conjoint Analysis:

Introduction, Additive tables, Multiplicative tables, Computing table margins based on an additive model, Applied conjoint analysis.

Unit –IV — **09 Hrs**

Decision Trees and Clustering:

Introduction, Basic tree model, Categorical or Quantitative Predictors, Decision Trees, Regression Trees, Bias-Variance Tradeoff, Pruning and Cross-Validation, Loss functions**.**

Cluster Analysis-Introduction, Types of Clustering, Correlations and Distances, Hierarchical Clustering, Partitioning via k-means.

Unit –V — **09 Hrs**

Time Series Analysis:

Time series analysis-Trend, Seasonality, Noise decomposition, Autocorrelation, Stationarity, Lag features, Overview of Autoregressive (AR), Moving Average (MA), Autoregressive Integrated Moving Average (ARIMA) models.

Course Outcomes:	
CO1	Apply fundamental concepts of multiple regression, design of experiments to analyze and interpret data in discriminant analysis, factor analysis, conjoint analysis, and statistical learning methods.
CO2	Analyze and interpret data using regression, experimental design, and multivariate techniques, and apply suitable statistical learning models to real-world problems.

CO3	Estimate model parameters and interpret results for multiple linear regression, ANOVA, discriminant analysis, factor analysis, and conjoint analysis to support data-driven decision-making using statistical learning techniques.
CO4	Implement multiple linear regression, ANOVA, discriminant analysis, factor analysis, conjoint analysis and time series analysis to support decision-making using statistical methods for solving engineering problems.

Reference Books	
1	An Introduction to Multivariate Analysis, T. W. Anderson, 3rd Edition, 2003, John Wiley & Sons, New Jersey, ISBN: 0-471-36091-0.
2	Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability for Engineers", John Wiley & Sons, 7th Edition, 2019, ISBN: 9781119570615.
3	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer Series in Statistics, 2nd Edition, 2009.
4	Richard A Jhonson and Dean W. Wichern, Applied Multivariate Statistical Analysis, 6th Edition, Pearson Education, ISBN-13: 978-0-13-187715-3.
5	Statistics I, SYSTAT 10.2, ISBN 81-88341-04-5.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	COMPONENTS	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **THREE** tests will be conducted (Two regular tests and one optional improvement test). Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
INDUSTRY 5.0 **Category: Institutional Elective (Group -G)** **(Theory)**						
Course Code	**:**	**ME375TGP**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42 Hrs**		**SEE Duration**	**:**	**3 Hours**

Unit – I	**06 Hrs**
Evolution to Industry 5.0: Historical overview of industrial revolutions. Transition from automation-centric to human-centric manufacturing. Key drivers: personalization, sustainability, and resilience. Comparison between Industry 4.0 and Industry 5.0 frameworks.	
Unit -II	**08 Hrs**
Human-Machine Collaboration: Introduction to collaborative robots (cobots) and their applications. Designing ergonomic and safe human-robot workspaces. Augmented Reality (AR) and Virtual Reality (VR) in training and maintenance. Case studies on successful human-robot collaboration.	
Unit –III	**08 Hrs**
Advanced Digital Technologies: Digital twins and their role in predictive maintenance and system optimization. Integration of AI and machine learning in manufacturing processes. Cyber-Physical Systems (CPS) and their applications. Edge computing and real-time data analytics.	
Unit –IV	**10 Hrs**
Sustainable and Resilient Manufacturing: Principles of sustainable manufacturing and circular economy. Life Cycle Assessment (LCA) and its importance in product design. Strategies for building resilient supply chains. Regulatory frameworks and standards for sustainable practices.	
Unit - V	**10 Hrs**
Implementation and Case Studies: Roadmap for transitioning to Industry 5.0. Challenges and solutions in adopting Industry 5.0 principles. Case studies from automotive, aerospace, and electronics industries. Future trends and research directions in Industry 5.0.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Assess the challenges of implementing Industry 5.0 principles in diverse industrial applications.
CO2	Analyze the strategies for transitioning from Industry 4.0 to Industry 5.0 in human-centric manufacturing systems.
CO3	Evaluate the benefits of integrating collaborative technologies and sustainable practices in smart manufacturing.
CO4	Examine the role of human-machine collaboration and ethical data-driven decision-making in achieving resilient and adaptive production systems.

Reference Books	
1.	Industry 5.0: The Future of the Industrial Economy, Uthayan Elangovan, 2022, CRC Press, 1st Edition, ISBN: 9781032041278 (Unit I)
2.	Industry 5.0: Concepts and Strategies for Digital Transformation, Kaswan, Rathi, Garza-Reyes, 2025, CRC Press, 1st Edition, ISBN: 9781032878218 (Unit II, V)
3.	Industry 5.0: Design, Standards, Techniques and Applications for Manufacturing, Leong, 2024, The IET, 1st Edition, ISBN: 9781837240098 (Unit IV)
4.	Towards Industry 5.0, Durakbasa, Gencyilmaz, 2022, Springer, 1st Edition, ISBN: 9783031244568 (Unit III, V)
5.	Intelligent Manufacturing: Smart Choice, Sunil Kumar Wadhwa, 2023, ISBN: 9781802279153

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50Marks, adding upto 100 Marks. FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20) ADDING UPTO 40 MARKS.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRICS FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
PRINCIPLES OF ASTROPHYSICS **Category: Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**PY375TGQ**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	42L		**SEE Duration**	**:**	**3 Hours**

Unit-I	**08 Hrs**
The Celestial Sphere: The Geocentric Universe, Retrograde motion, The Copernican revolution, The celestial sphere, Altitude–Azimuth and Equatorial Coordinate System, Precession. **Celestial Mechanics:** Kepler's Laws of Planetary Motion from Newton's laws of mechanics, Position in the Orbit. **Spectrum of Light:** Stellar parallax, The magnitude scale, Apparent and Absolute Magnitude, Blackbody radiation and temperature, Spectral lines - Kirchhoff's Laws, Spectrographs.	
Unit – II	**09 Hrs**
Special Relativity: Einstein's postulates, The relativity of simultaneity, Time dilation, Length contraction, Galilean transformations, Lorentz transformations, Velocity transformation, Space-time diagrams and causality. Relativistic momentum and energy. **General Relativity:** The Principle of Equivalence, Gravitation as space-time curvature, (1) perihelion advance of planet Mercury, (2) gravitational red shift and (3) gravitational bending of light (qualitative).	
Unit –III	**08 Hrs**
Telescopes: Resolution and the Rayleigh Criterion, Aberrations, The Brightness of an Image and focal ratio, Refracting and Reflecting Telescopes, Adaptive Optics, Electronic Detectors - CCD, Radio Telescopes - Spectral Flux Density, Large Apertures and Interferometry, Infrared, Ultraviolet, X-Ray, and Gamma-Ray Astronomy.	
Unit –IV	**09 Hrs**
Stars: Stellar Spectra, The Harvard Spectral Classification, The Hertzsprung–Russell Diagram, Binary Stars and Stellar Masses - Classification of Binary Stars, Stellar Structure - Internal Equilibrium Conditions, The Sun - The Atmosphere, Solar Activity; Stellar Energy Sources - Nuclear Fusion Reactions, Stellar Evolution - Evolutionary Time Scales, The Contraction of Stars Towards the Main Sequence, The Main Sequence Phase, The Giant Phase, The Final Stages of Evolution - White Dwarfs, Neutron Stars, Black Holes.	
Unit –V	**08 Hrs**
Galaxies: The Classification of Galaxies, Masses, Galactic Structures, Structural Components of the Milky Way, Dynamics of Galaxies, Systems of Galaxies, The Origin and Evolution of Galaxies. The Interstellar Medium - Interstellar Dust, Interstellar Gas, Cosmic Rays. **Cosmology:** The Olbers Paradox, Hubble's Law, Cosmic Microwave Background Radiation, History of the Universe, Astrobiology.	

Course Outcomes	
CO1	Apply the principles of celestial mechanics to describe planetary motion, orbital dynamics, and gravitational interactions in astrophysical systems.
CO2	Interpret the foundational concepts of special relativity and analyse the implications of time dilation, length contraction, and relativistic mass in astronomical contexts.
CO3	Compare and evaluate different types of telescopes and their applications in various regions of the electromagnetic spectrum for observational astronomy.
CO4	Analyse the physical properties, life cycles, and classifications of stars using observational data and theoretical models.

Reference Books	
1.	Bradley W. Carroll, Dale A. Ostlie, An Introduction to Modern Astrophysics: United States Edition, Pearson; 1st edition (7 September 2017), ISBN-10: 1108422160
2.	H. Karttunen, P. Kröger, H. Oja, M. Poutanen, K. J. Donner (Eds.), Fundamental Astronomy, 5th Edition, Springer, 2007, ISBN 978-3-540-34143-7
3	Suresh Chandra Mohit Kumar, A Textbook of Astronomy and Astrophysics, Dreamtech Press, 1 Nov 2019, ISBN-10: 9389520908
4.	Padmanabhan, T., Theoretical Astrophysics, Vols.1-3, 2015, Cambridge University Press, ISBN-9780521016278
5.	Modern Cosmology, Academic Press Inc; 2nd edition, 7 July 2020, ISBN-10: 0128159480,
6.	Harwit, M. Astrophysical Concepts, 4th Edition, 2015, Springer-Verlag, ISBN-10 : 1441921990
7.	Shapiro, Stuart L., and Saul A. Teukolsky. Black Holes, White Dwarfs, and Neutron Stars, 1st Edition, 1983, Wiley, ISBN: 9780471873167

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
Mathematics of Music **Category : Institutional Elective – II (Group G)** **(Theory)**						
Course Code	**:**	**MA375TGR**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Fundamentals of Sound and Musical Structure Nature of sound: frequency, amplitude, harmonics, waveforms; Musical pitch and logarithmic perception of frequency, Shruti, Swara, Saptak; Musical notation systems.	
Unit – II	**09 Hrs**
Tuning Systems and Modular Arithmetic in Music Pythagorean tuning, Just Intonation, and Equal Temperament, Circle of Fifths and the irrationality of log(3/2), Modular arithmetic and pitch class sets, Construction of scales: Melakarta Rāga(Carnatic) and Thaat (Hindustani) systems.	
Unit –III	**09 Hrs**
Rhythm, Tāla, and Combinatorial Structures Tāla systems: concepts of mātra, vibhāga, āvartana; Analysis of Carnatic tālas (Adi, Rupaka, Jhampa, etc.); Combinatorics of tāla patterns and variation (korvais, tihāis); Algorithmic composition of rhythmic phrases	
Unit –IV	**09 Hrs**
Timbre, Music Analysis and Processing Timbre and harmonic spectra, Fourier series and transforms in sound decomposition, Sub-harmonics, Limitation of Fourier Analysis: Noise; Introduction to sound synthesis and spectral envelopes.	
Unit –V	**09 Hrs**
Algorithmic Music and Perception Fractals and recursion in music, Algorithmic and generative composition, Mathematical models of musical perception, Psychoacoustics: pitch, consonance/dissonance, critical bands.	

Course Outcomes	
CO1	**Analyze musical phenomena using mathematical tools**
CO2	**Model rhythm, harmony, and timbre using algebraic and computational methods.**
CO3	**Apply signal processing concepts to sound synthesis and analysis.**
CO4	**Explore algorithmic and generative approaches to musical composition.**

Reference Books	
1.	Benson, D. J. (2006). *Music: A Mathematical Offering*. Cambridge University Press, ISBN: 978-0521619998.
2.	Fauvel, J., Flood, R., & Wilson, R. (Eds.). (2003). *Music and Mathematics: From Pythagoras to Fractals*. Oxford University Press, ISBN: 978-0199298938.
3.	Loy, G. (2006). *Musimathics: The Mathematical Foundations of Music* (Vol. 1 & 2). MIT Press, ISBN: 9780262516556.

4.	Sethares, W. A. (2005). *Tuning, Timbre, Spectrum, Scale* (2nd ed.). Springer, ISBN: 978-1852337971.
5	Radhika Iyer (2018), *Elements Of Indian Music: The Melakarta System*, ISBN: 1513460854.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
Cognitive Psychology **Category: Institutional Elective Course (Group G)** **Theory**						
Course Code	**:**	**HS375TGS**		**CIE**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**
Unit-I						**09 Hrs**
Fundamentals & current trends in cognitive psychology: Definition, Emergence of cognitive psychology, Cognitive development theories and perspectives; Current status and trends in cognitive Psychology. Research methods in cognitive psychology- goals of research. Distinctive research method. Current areas of research in cognitive psychology, (Educational application, marketing and advertisement).						
Unit – II						**09 Hrs**
Basic cognitive processes: Sensation and Perception: Sensory receptors and Brain, The constancies, pattern recognition, Modularity, Imagery: Characteristics of Imagery, Cognitive maps. Attention and Information processing: Nature and Types, Theories and models of attention. Neuropsychological studies of Attention. Consciousness: – meaning, Modern Theories and Contemporary Research of Consciousness.						
Unit –III						**09 Hrs**
Reasoning, Creativity and Problem- Solving: Reasoning definition, types, influencing factors. Creativity-definition, steps involved in creative process, obstacles involved in creativity, enhancing techniques of creativity. Meta cognition: Problem solving, steps in problem solving, types, methods, obstacles and aids of problem Solving.						
Unit –IV						**09 Hrs**
Psycholinguistics: Definition, characteristics of language, theories - Chomsky. Structure of Language (Properties), Stages in Language Development, Neurological Language. Comprehension and Production. Bilingualism, Multilingualism and Learning disability.						
Unit –V						**09 Hrs**
Cognitive Neuroscience: Definition and emergence of cognitive neuroscience, Scope of Neuroscience, structure and functions of Brain, Brain Plasticity, Intelligence and Neuroscience. Meta-cognitive strategies. Artificial intelligence, Robotics, Models on Information Processing.						

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Describe the basic theories, principles, and concepts of cognitive psychology as they relate to behaviour and mental processes.
CO2	Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process.
CO3	Develop understanding of psychological attributes such as reasoning, problem solving creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement.
CO4	Apply the theories into their own and others' lives in order to better understand their personalities and experiences.

Reference Books	
1.	Sterberg R.J and Sternberg Karin (2012) Cognitive Psychology 6th Edition Woods worth Cengage Learning
2.	Psychology-themes and variations, Wayne Weiten, IV edition, Brooks / Cole Publishing Co.
3.	Psychology Robert A. Baron, III edition (1995) Prentice Hall India.
4.	Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar / presentation / demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
PRINCIPLES & PRACTICES OF CYBER LAW **Category : Institutional Elective Course (Group G)** **Theory**						
Course Code	**:**	**HS375TGT**		**CIE**	**:**	**100**
Credits: L:T:P	**:**	**03 :0:0**		**SEE**	**:**	**100**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction - Origin and meaning of Cyberspace; Introduction to Indian Cyber Law, Distinction between Cyber Crime and Conventional Crime, Cyber Criminals and their Objectives, Kinds of Cyber Crime& Cyber Threats, challenges of cybercrimes, Overview of General Laws and Procedures in India. **Cyber Jurisdiction**-Concept of Jurisdiction, Jurisdiction in Cyberspace, Issues and concerns of Cyberspace Jurisdiction in India, International position of Cyberspace Jurisdiction, Judicial interpretation of Cyberspace Jurisdiction. Activities: Case Studies and Practical Applications	
Unit – II	**09 Hrs**
Information Technology Act: A brief overview of Information Technology Act 2000, IT Act 2000 vs. IT Amendment Act 2008, Relevant provisions from Indian Penal Code, Indian Evidence Act, Bankers Book Evidence Act, Reserve Bank of India Act, etc. **Electronic Signature and Digital Signature**- Meaning & Concept of Relevance of Signature, Handwritten signature vs Digital Signature, Technological Advancement and development of signature, Digital Signature: IT Act, 2000, Cryptography, Public Key and Private Key, Public Key Infrastructure Electronic Signature vs. Digital Signature, E-Commerce under IT Act2000, Issues and challenges of E-Commerce. Activities: Case Studies and Practical Applications	
Unit –III	**09 Hrs**
Data Protection and Privacy Concerns in Cyberspace - Need to protect data in cyberspace, Types of data, Legal framework of data protection, Data protection bill -an overview, GDPR, Concept of privacy, Privacy concerns of cyberspace, Constitutional framework of privacy, Judicial interpretation of privacy in India. **Data Privacy and Data Security**- Defining data, meta-data, big data, non- personal data. Data protection, Data privacy and data security, Data protection regulations of other countries- General Data Protection Regulations (GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., social media- data privacy and security issues. Activities: Case Studies and Practical Applications	
Unit –IV	**09 Hrs**
IP Protection Issues in Cyberspace **Copyright Issues in Cyberspace**- Copyright infringement in digital environment. Indian legal protection of copyright in cyberspace. **Trademark Issues in Cyberspace** -Domain Name Vs Trademark, Domain Name dispute and Related Laws, Different Form of Domain in Cyberspace. **Patent Issues in Cyberspace**-Legal position on Computer related Patents - Indian Position on Patents. Activities: Case Studies and Practical Applications	
Unit –V	**09 Hrs**

Digital Forensics- Computer Forensics, Mobile Forensics, Forensic Tools, Anti-Forensics
Cyber Crime & Criminal Justice Agencies -Cyber Crime Cells, Cyber Crime Appellate- Cyber Crime Investigation, Investigation Procedure- FIR -Charge Sheet

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the importance of professional practice, Law and Ethics in their personal lives and professional careers.
CO2	Build in Depth Knowledge of Information Technology Act and Legal Frame Work of Right to Privacy, Data Security and Data Protection.
CO3	Identify the bone of contentions of cybercrime investigation techniques, evaluate problem-solving strategies, and develop science-based solutions.
CO4	Develop an Understanding of the Relationship Between E-Commerce and Cyberspace.

Reference Books	
1.	Cyber Law by Dr. Pavan Duggal Publisher: LexisNexis, ISBN-10: 8196241070, ISBN-13: 978-8196241070
2.	Introduction to Information Security and Cyber Laws by Surya Prakash Tripathi, Ritendra Goel, Praveen Kumar Shukla ASIN: 9351194736, Publisher: Dream tech Press, ISBN-10: 9789351194736, ISBN-13: 978-9351194736.
3.	Cyber Forensics in India: A Legal Perspective by Nishesh Sharma,1st Edition, ISBN: 9788131250709.
4.	Cyber Laws, Justice Yatindra Singh, 6th Edition, Vol. 1, ISBN: 9789351437338

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VII						
SUMMER INTERNSHIP						
Course Code	**:**	**CD376SI**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**0:0:3**		**SEE**	**:**	**100Marks**
No. of Weeks	**:**	**08**		**SEE Duration**	**:**	**3 Hours**

GUIDELINES

1. The duration of the internship shall be for a period of ***8 weeks*** on full time basis after VI semester final exams and before the commencement of VII semester.
2. The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3. Internship must be related to the field of specialization of the respective UG programme in which the student has enrolled.
4. Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5. Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory colour for UG circuit Programs and Light Blue for Non-Circuit Programs.
7. The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization: Organizational structure, Products, Services, Business
    - Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 - Activities of the Department
    - Chapter 3 - Tasks Performed: summary of the tasks performed during 8-week period
    - Chapter 4 – Reflections: Highlight specific technical and soft skills acquired during internship
    - References & Annexure

Course Outcomes:

After going through the internship, the student will be able to:

CO1: Apply Engineering and Management principles

CO2: Analyze real-time problems and suggest alternate solutions

CO3: Communicate effectively and work in teams

CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):
The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews. The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments.	50 Marks
Review - II	Importance of resource management, environment and sustainability, presentation skills and report writing	50 Marks

Scheme for Semester End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

Scheme of Evaluation for SEE	
Particulars	**%Marks**
Project Synopsis (Initial Writeup)	10%
Project Demo/Presentation	30%
Methodology and Results Discussion	30%
Project Work Report	10%
Viva-voce	20%
Total	100

Semester: VIII						
MAJOR PROJECT						
Course Code	**:**	**CD481P**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**0:0:12**		**SEE**	**:**	**100 Marks**
Hours/Week	**:**	**24**		**SEE Duration**	**:**	**03 Hours**

GUIDELINES

1. The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.
2. The detailed Synopsis (approved by the department Project Review Committee) has to be submitted during the 1st week after the commencement of 8th semester.

Batch Formation:

- Students are free to choose their project partners from within the program or any other program.
- Each student in the team must contribute towards the successful completion of the project.
- The project may be carried out In-house / Industry / R & D Institution. The project work is to be carried out by a team of two to four students, in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process, the student can work independently.
- The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.
- In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.

Project Topic Selection:

The topics of the project work must be in the field of respective program areas or in line with CoE's(Centre of Excellence) identified by the college or List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.

Students can select courses in NPTEL from the discipline of Humanities and Social Sciences, Management, Multidisciplinary and Design Engineering. The course chosen could be either of 4w/8w/12w duration. The students need to enrol for a course, register for the exam and submit the e-certificate to the department, as and when it is released by NPTEL. The same will be considered as one of the components during project evaluation of phase 2 and phase 5.

Project Evaluation:

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.
- Weekly Activity Report (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of Industry project, during the course of project work, the internal guides will have continuous interaction with external guides and will visit the industry at least twice during the project period.
- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.

- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

Course Outcomes: After going through the major project, the student will be able to:

CO1: Apply knowledge of mathematics, science and engineering to solve respective engineering domain problems.

CO2: Design, develop, present and document innovative/multidisciplinary modules for a complete engineering system.

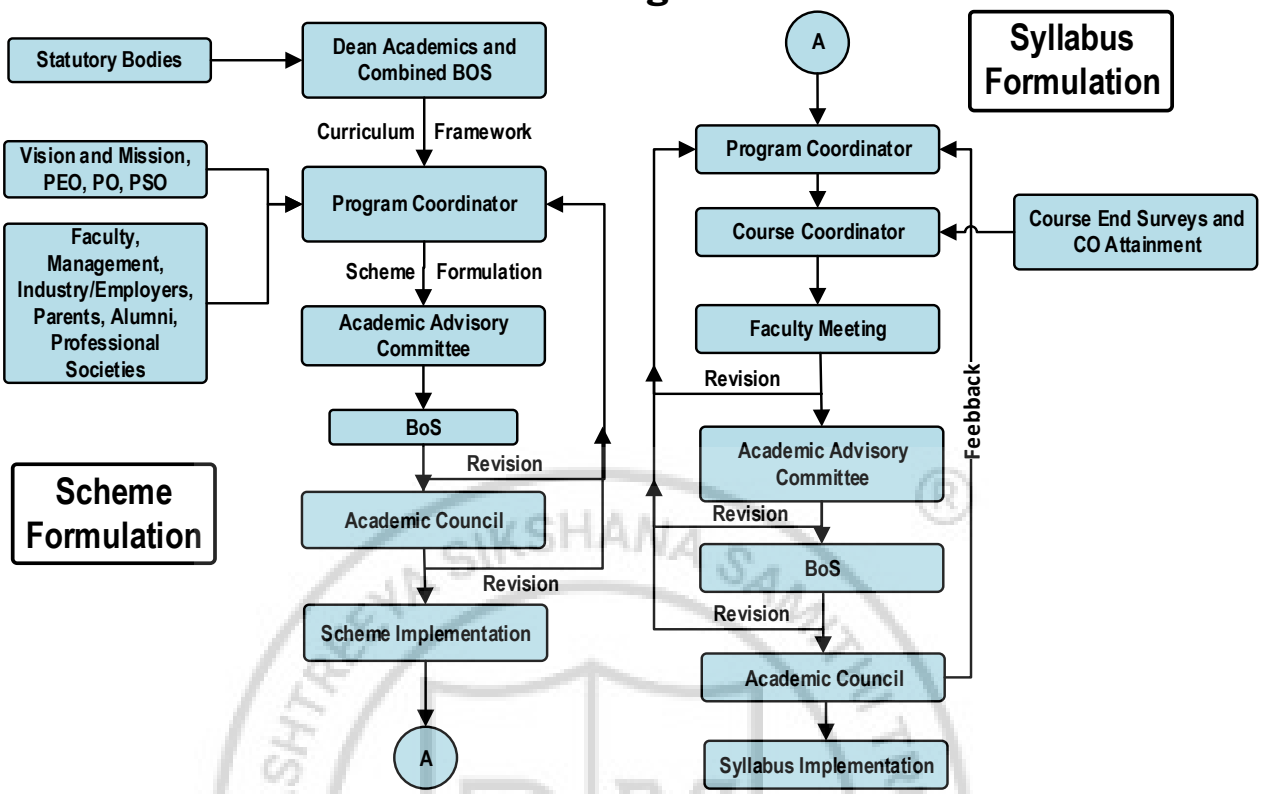
CO3: Use modern engineering tools, software and equipment to solve problem and engage in life-long learning to follow technological developments.

CO4: Function effectively as an individual, or leader in diverse teams, with the understanding of professional ethics and responsibilities.

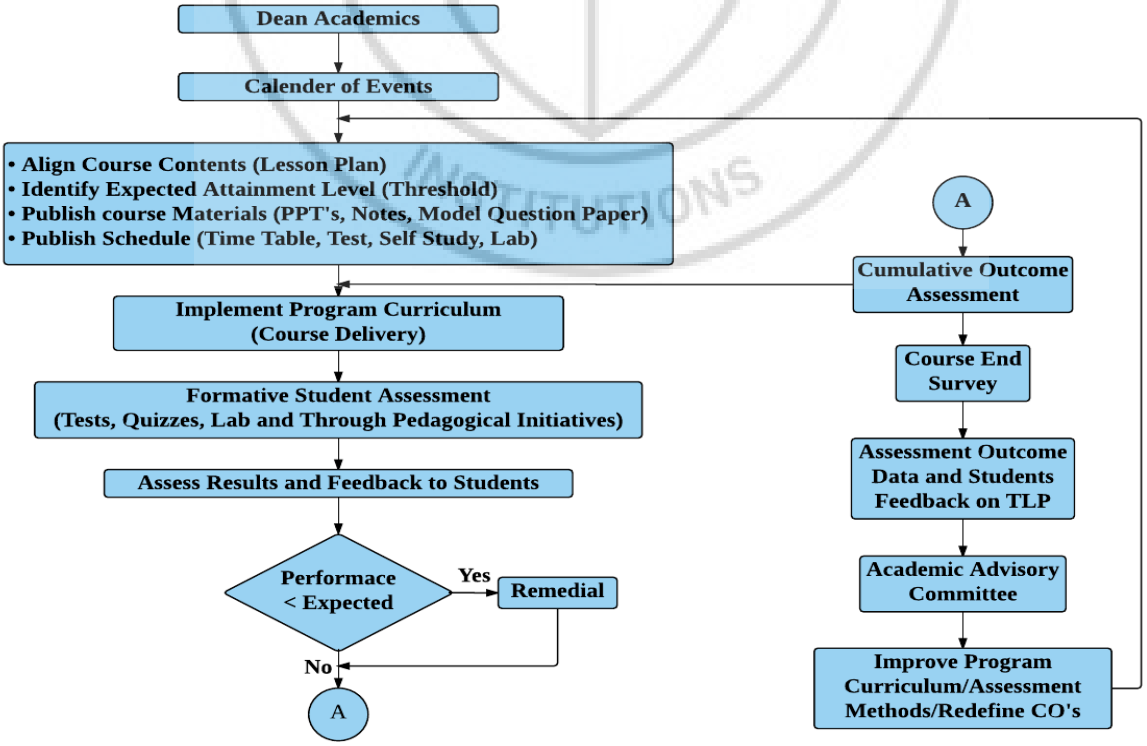
Scheme of Continuous Internal Evaluation (CIE):

Scheme of Evaluation for CIE		**Scheme of Evaluation for SEE**	
Particulars	**%Marks**	**Particulars**	**%Marks**
Project Evaluation I	10%	Project Synopsis (Initial Writeup)	10%
Project Evaluation II	20%	Project Demo/Presentation	25%
Project Evaluation III	25%	Methodology, Results and Discussion	25%
Project Evaluation Phase-IV (Submission of Draft Project Report for Verification) (Project Final Internal Evaluation)	25%	Project Work Report	15%
Publication	20%	Viva-voce	25%
Total	**100**	**Total**	**100**

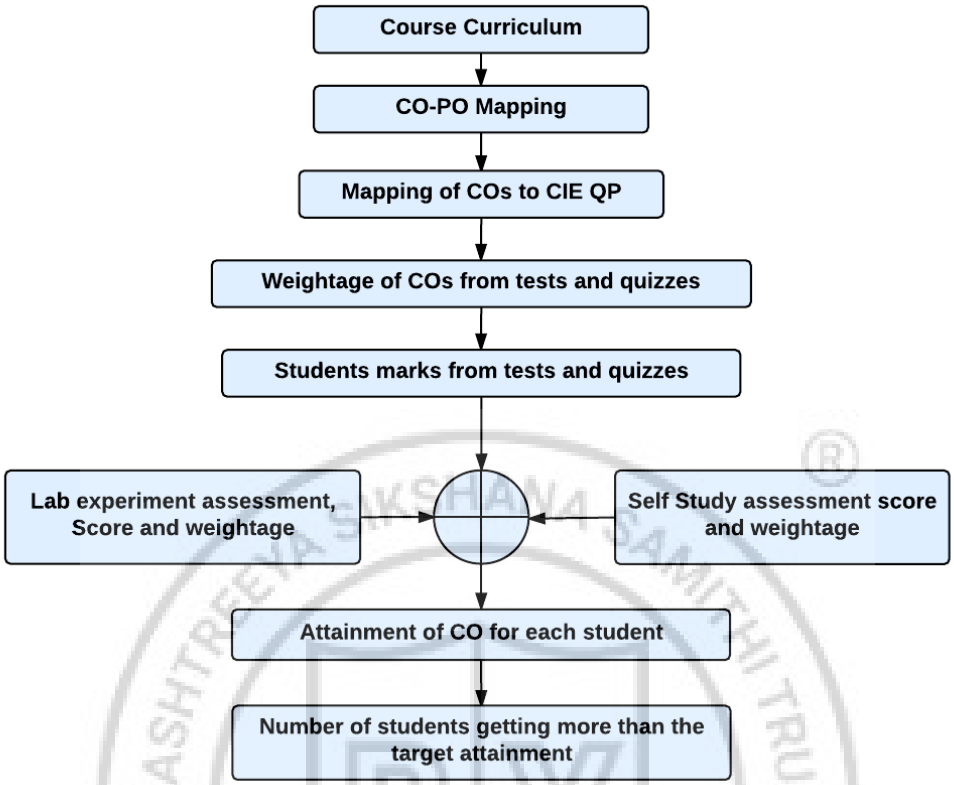
Curriculum Design Process



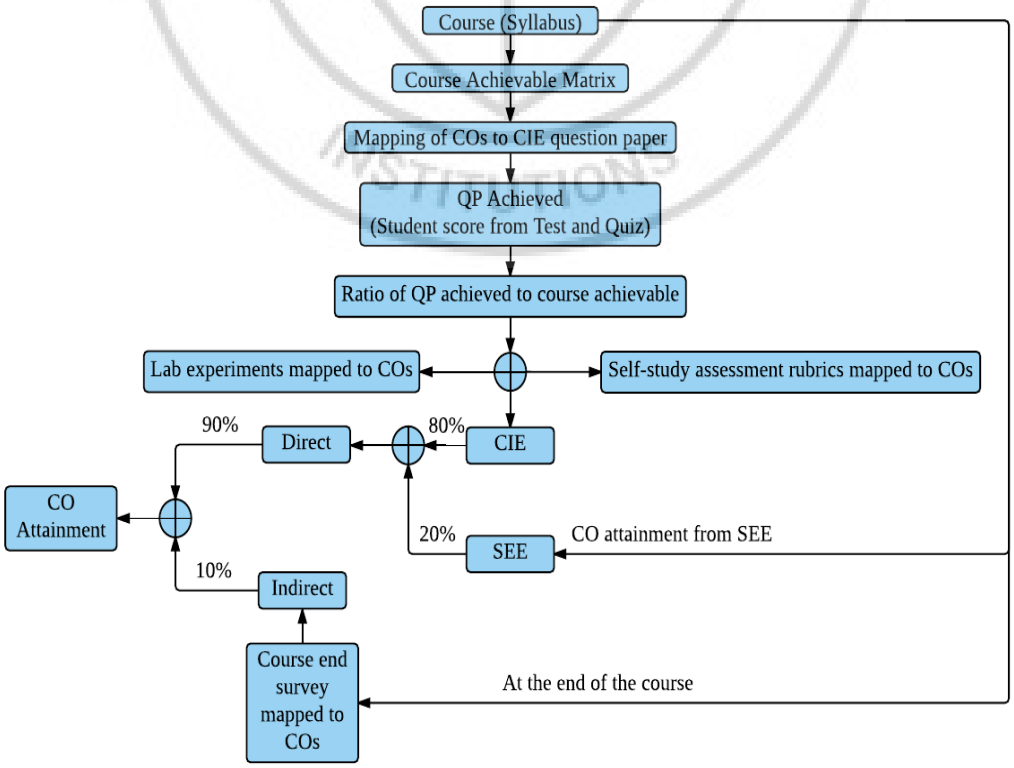
Academic Planning and Implementation



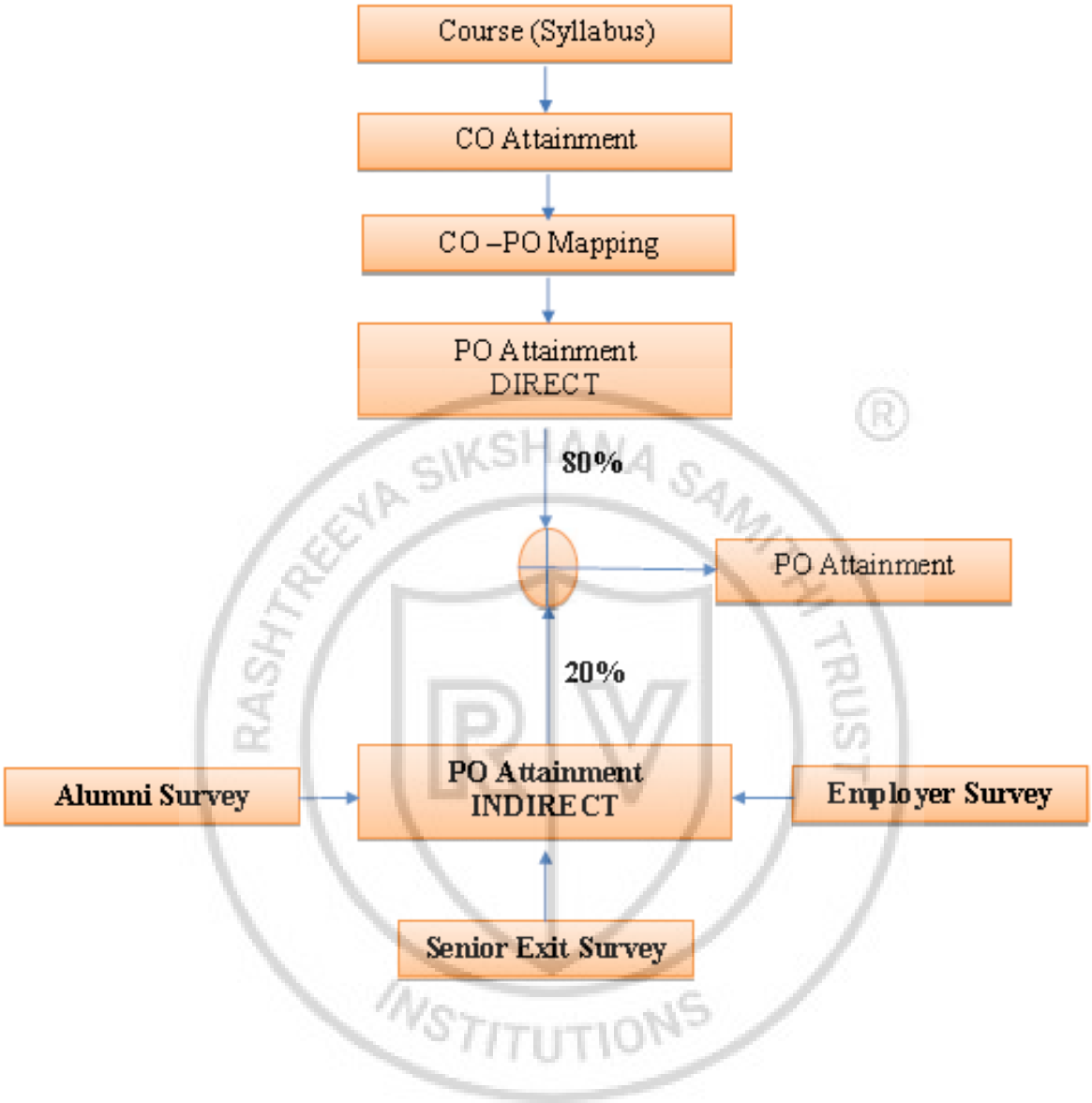
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



KNOWLEDGE & ATTITUDE PROFILE

- **WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- **WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- **WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- **WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- **WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- **WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- **WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- **WK9:** Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAM OUTCOMES (POs)

- **PO1:** Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- **PO2:** Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- **PO3:** Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- **PO4:** Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- **PO5:** Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- **PO6**: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- **PO7:** Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- **PO8:** Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- **PO9:** Communication: Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- **PO10:** Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- **PO11:** Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

INNOVATIVE TEAMS OF RVCE

Ashwa Mobility Foundation (AMF): Designs and fabricates Formula-themed race cars and mobility solutions to address urban transportation issues.

Astra Robotics Team: Focuses on designing and building application-specific robots.

Coding Club: Helps students gain coding skills and succeed in competitions like GSoC and ACM-ICPC.

Frequency Club Team: Works on software and hardware, emphasizing AI and Machine Learning.

Team Garuda: Develops a supermileage urban concept electric car and E-mobility products.

Team Jatayu: Builds low-cost UAVs with autonomous capabilities for various tasks.

Team Antariksh: Focuses on space technology and the development of operational rockets.

Team Chimera: Builds a Formula Electric Car through R&D in E-Mobility.

Helios Racing Team: Designs and tests All-Terrain Vehicles, participating in SAE's BAJA competitions.

Team Krushi: Creates low-cost farming equipment to assist farmers in cultivation and harvesting.

Team Vyoma: Designs and tests radio-controlled aircraft and UAVs.

Team Dhruva: Engages in astronomy-related activities and collaborates on projects with organizations like ICTS and IIA.

Ham Club: Promotes Amateur Radio and explores technical innovations in communications, especially for disaster response.

Chitrak : It is the official electric bike team of RV College of Engineering (RVCE) in Bangalore

Anoraniya:A Quantum based technical club initiated by students. The club is dedicated to addressing various technical challenges in quantum technologies and is on the verge of delivering some fascinating results.

Accelerate Club: organizes and participates in hackathons, bootcamps, workshops, and student-led innovation drives.

Cultural Activity Teams

1. AALAP (Music club)
2. DEBSOC (Debating society)
3. CARV (Dramatics club)
4. FOOTPRINTS (Dance club)
5. QUIZCORP (Quizzing society)
6. ROTARACT (Social welfare club)
7. RAAG (Youth club)
8. EVOKE (Fashion team)
9. f/6.3 (Photography club)
10. CARV ACCESS (Film-making

NSS of RVCE

NCC of RVCE

VISION

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

MISSION

- To deliver outcome based Quality education, emphasizing on experientiallearning with the state of the art infrastructure.
- To create a conducive environment for interdisciplinary research and innovation.
- To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
- To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
- 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