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RV College of Engineering ®

Autonomous
Institution Affiliated
to Visvesvaraya
Technological
University, Belagavi

Approved by AICTE,
New Delhi

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SCHEME & SYLLABUS
THIRD YEAR B.E. PROGRAMS

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

BACHELOR OF ENGINEERING (B.E.)
2021 SCHEME

ACADEMIC YEAR 2023-24

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.	IE	Institutional Elective
7.	HS	Humanities and Social Sciences
8.	PHY	Physics
9.	CHY	Chemistry
10.	MAT	Mathematics
11.	AS	Aerospace Engineering
12.	AI	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)

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Bachelor of Engineering in
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
V Semester

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total				Theory	Lab		Theory	Lab
1	21HS51A	Intellectual Property Rights & Entrepreneurship	3	0	0	3	HSS	Theory	1.5	100	***	3	100	****
2	21AI52	Artificial Intelligence and Machine Learning (Common to AI, CS, IS)	3	0	1	4	AI	Theory + Lab	1.5	100	50	3	100	50
3	21AI53	Natural Language Processing and Transformers	3	0	1	4	AI	Theory + Lab	1.5	100	50	3	100	50
4	21AI54	Cloud Computing Technology and Architectures	3	1	0	4	AI	Theory	1.5	100	***	3	100	***
5	21AI55BX	Professional Core Elective-I **(Group-B)**	3	0	0	3	AI	Theory	1.5	100	***	3	1000	***
6	21AI56CX	Professional Core Elective-II **(Group C)**	2	0	0	2	AI	**NPTEL**	1.5	50	***	3	50	***
7	21AII57	Summer Internship- II	0	0	2	2	AI	Internship	1.0	****	50	3	***	50
		Total				**22**								

GROUP-B			
Sl. No.	**COURSE CODE**	**COURSE TITLE**	**CREDITS**
1	21AI55B1	Information Retrieval Systems	**03**
2	21AI55B2	Extended Reality	**03**
3	21AI55B3	Internet of Things and Computing Paradigms	**03**
4	21AI55B4	Distributed and Parallel Computing	**03**

GROUP C - NPTEL			CREDITS
Sl. No.	**Course Code**	**Course Title**	**02**
1	21CS56C1	Information Security – 5 – Secure Systems Engineering	**02**
2	21ME56C2	Design, Technology and Innovation	**02**
3	21AI56C3	Systems Engineering: Theory & Practice	**02**
4	21AI56C4	Edge Computing	**02**

Bachelor of Engineering in
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
VI Semester

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total				Theory	Lab		Theory	Lab
1	21HS61B	Principles of Management & Economics	3	0	0	3	HSS	Theory	1.5	100	***	3	100	****
2	21AI62	Big Data Technologies	3	0	1	4	AI	Theory + Lab	1.5	100	50	3	100	50
3	21AI63	Artificial Neural Networks and Deep Learning	3	0	1	4	AI	Theory + Lab	1.5	100	50	3	100	50
4	21AI64DX	Professional Core Elective-III **(Group – D)**	3	0	0	3	AI	Theory	1.5	100	***	3	100	***
5	21AI65EX	Professional Core Elective (Cluster Elective) **(Group- E)**	3	0	0	3	Resp. BoS	Theory	1.5	100	***	3	1000	***
6	21IE6FX	Institutional Electives – I **(Group F)**	3	0	0	3	Resp. Bos	Theory	1.5	100	***	3	100	***
		Total				**20**								

GROUP - D			
Sl. No.	**Course Code**	**Course Title**	**CREDITS**
1	21AI64D1	Artificial Intelligence Integrated Software Engineering	**03**
2	21AI64D2	Advanced Topics in Artificial Intelligence	**03**
3	21AI64D3	Nature Inspired Computing	**03**
4	21AI64D4	Social Network Analysis	**03**

GROUP –E (Common to AI,CS,IS)			
Sl. No.	**Course Code**	**Course Title**	**CREDITS**
1	21AI65E1	Engineering Applications of Artificial Intelligence	**03**
2	21AI65E2	Quantum Computing	**03**
3	21CS65E1	Computer Vision	**03**
4	21CS65E2	Enterprise Architecture	**03**
5	21IS65E1	Human Computer Interaction	**03**
6	21IS65E2	Cloud Computing	**03**

GROUP F – Institutional Elective			
Sl. No.	**Course Code**	**BoS**	**Course Title**
1	21IE6F1	CH	Industrial Safety and Risk Management
2	21IE6F2	EE	Renewable Energy Systems
3	21IE6F3	IM	Systems Engineering
4	21IE6F4	ME	Mechatronics
5	21IE6F5	MA	Mathematical Modelling
6	21IE6F6	ME	Industry 4.0 – Smart Manufacturing for The Future
7	21IE6F7	HSS	Industrial Psychology for Engineers
8	21IE6F8	IM	Elements of Financial Management
9	21IE6F9	HSS	Universal Human Values-II
10	21IE6F10	EC	Human Machine Interface (Industry Offered Elective)

Semester: V / VI						
INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP (Common to all Programs) (Theory)						
Course Code	**:**	**21HS51A**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I — **09 Hrs**

Introduction: Types of Intellectual Property

Patents: Introduction, Scope and salient features of patent; patentable and non-patentable inventions, Patent Procedure - Overview, Transfer of Patent Rights; protection of traditional knowledge, Infringement of patents and remedy, Case studies

Patent Search and Patent Drafting, Commercialization and Valuation of IP. Case examples.

Unit – II — **08 Hrs**

Trade Secrets: Definition, Significance, Tools to protect Trade secrets in India.

Trade Marks: Concept, function and different kinds and forms of Trade marks, Registrable and non- registrable marks. Registration of Trade Mark; Deceptive similarity; Transfer of Trade Mark, ECO Label, Passing off, Infringement of Trade Mark with Case studies and Remedies. Case Examples.

Unit –III — **08 Hrs**

Industrial Design: Introduction of Industrial Designs Features of Industrial, Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies.

Copy Right: Introduction, Nature and scope, Rights conferred by copy right, Copy right protection, transfer of copy rights, right of broad casting organizations and performer's rights, Exceptions of Copy Right, Infringement of Copy Right with case studies.

Introduction to Cyber law: Information Technology Act, cybercrime and e-commerce, data security, confidentiality, privacy, international aspects of computer and online crime.

Unit –IV — **09 Hrs**

Entrepreneurship: Introduction, Evolution of the Entrepreneurship, Importance of Entrepreneurship, Concept of Entrepreneurship, Characteristics of a successful Entrepreneur, Classification of Entrepreneur, Myths of Entrepreneurship, Entrepreneurial Development Models, Problems Faced by Entrepreneurs and Capacity Building for Entrepreneurship .Women Entrepreneurship in Asia, Women Entrepreneurship in India, Challenges Faced by Women Entrepreneurs. Case studies.

Entrepreneurship in the New Age: Getting to know your Business, it's Eco-system and Environment, Passion and Values driving, building and growing Family businesses, Challenges and suggested management approaches.

Unit –V — **11 Hrs**

Business Plans: Introduction ,Purpose of a Business Plan ,Contents of a Business Plan, Business Concept, Business Strategy, Marketing Plan, Operations Plan, Financial Plan, Presenting a Business Plan, Oral and Visual Presentation, Why Do Some Business Plans Fail? Procedure for Setting Up an Enterprise, Business Models and Business Model Innovation Creating a Business Plan. Case lets/Case studies.

Preparation of project: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of. Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Use of standard templates for preparation of project report.

Reference Books	
1.	Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602.
2.	Intellectual Property and the Internet, Rodney Ryder, 2002, Lexis Nexis U.K., ISBN: 8180380025, 9788180380020.
3.	Poornima M. Charantimath "Entrepreneurship Development and Small Business Enterprise", Pearson Education, 2005, ISBN: 9788177582604
4.	Dynamics of Entrepreneurial Development & Management-Vasant Desai, Himalaya Publishing House, 6th Edition, 2018, ISBN - 978-93-5299-133-4
5	Entrepreneurial development, Khanka, Shobhan Singh, S. Chand Publishing, 2006, ISBN - 8121918014, 9788121918015

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

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)* (Small case lets and case example in one subdivision)	
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: V						
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING **Category: PROFESSIONAL CORE COURSE** **(Common to AI,CS,IS)** **(Theory and Practice)**						
Course Code	**:**	**21AI52**		**CIE**	**:**	**100+50 Marks**
Credits: L: T: P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**9Hrs.**
Introduction: What is AI? **Intelligent agents:** Intelligent Agents: Agents and environment; Rationality; the nature of environments; the structure of agents **Problem Solving & Uninformed Search Strategies:** Problem-solving agents, Breadth-first Search, Depth-first Search, Depth-limited Search and Iterative Deepening Depth First Search	
Unit – II	**9Hrs.**
Informed (Heuristic) Search Strategies: A* Search, Heuristic Functions **Beyond Classical Search:** Local Search Algorithms and Optimization Problems, Hill-climbing Search, Simulated Annealing, Local-beam Search, Genetic Algorithms **Adversarial search:** Games, Optimal decision in games, Alpha-Beta Pruning	
Unit –III	**9Hrs.**
Supervised Learning: Basic Concepts, General Framework for Classification **Decision Tree Classifier**-A Basic Algorithm to Build a Decision Tree, Methods for Expressing Attribute Test Conditions, Measures for Selecting an Attribute Test Condition, Algorithm for Decision Tree Induction, Characteristics of Decision Tree Classifiers, **Model Overfitting**- Reasons for Model Overfitting **Model Selection** - Using a Validation Set, Incorporating Model Complexity, Estimating Statistical Bounds, Model Selection for Decision Trees, Model Evaluation	
Unit –IV	**9Hrs.**
Nearest Neighbor Classifiers-Characteristics of Nearest Neighbor Classifiers **Naive Bayes Classifier**-Basics of Probability Theory, Naive Bayes assumption **Logistic Regression**-Logistic Regression as a Generalized Linear Model, Learning Model Parameters, Characteristics of Logistic Regression **Ensemble Methods** – Methods for constructing Ensemble classifier, Bagging, Boosting, Random Forests	
Unit –V	**9Hrs**
Unsupervised Learning- Overview, What Is Cluster Analysis, Different Types of Clustering's, Different Types of Clusters **K-means**-The Basic K-means Algorithm, Additional Issues, Bisecting K-means, K-means and Different Types of Clusters, Strengths and Weaknesses, K-means as an Optimization Problem **Cluster Evaluation**-Overview, Unsupervised Cluster Evaluation Using Cohesion and Separation, Unsupervised Cluster Evaluation Using the Proximity Matrix, Determining the Correct Number of Clusters, Supervised Measures of Cluster Validity, Assessing the Significance of Cluster Validity Measures, Choosing a Cluster Validity Measure	

Laboratory Component

PART-A	
Sl. No	• **Implement the following algorithms (5 to 8) using required statistical formulae and do not use direct API's** • **Demonstrate the working of the algorithms by considering appropriate datasets** • **Display the values of all the model parameters**
1.	Solve the Tic-Tac-Toe problem using the Depth First Search technique.
2.	Demonstrate the working of Alpha-Beta Pruning.
3.	Solve the 8-Puzzle problem using the A^* algorithm
4.	Implement a Hill-climbing search algorithm to maximize a single variable function f(x).
5.	Logistic regression algorithm.
6.	Naïve Bayes Classifier
7.	KNN algorithm.
8.	K- means algorithm

Two students from the same batch must develop a Machine Learning model on the problem statements chosen from Agriculture, Health Care, Manufacturing, and Process Control/Automation Domains related to Indian Scenarios.

- The data collected should be cleansed and pre-processed.
- The complete EDA process has to be demonstrated
- Selection of the suitable algorithms and model-building
- Model evaluation has to be carried out by selecting the proper metrics
  Prediction/classification results have to be obtained and should be demonstrated through visualizations

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain and apply AI and ML algorithms to address various requirements of real-world problems.
CO2	Design and develop AI and ML solutions to benefit society, science, and industry.
CO3	Use modern tools to create AI and ML solutions.
CO4	Demonstrate effective communication through team presentations and reports to analyze the impact of AI and ML solutions on society and nature.
CO5	Conduct performance evaluation, modeling, and validation of AI and ML solutions benefiting lifelong learning.
Reference Books	
1.	AI – A Modern Approach ,Stuart Russel, Peter Norvig, 3rd Edition, 2010, Pearson, ISBN-13: 978-0136042594
2.	Artificial Intelligence Basics: A Self Teaching Introduction, Neeru Gupta and Ramita Mangla, Mercury Learning and Information, 1st Edition, 2020, ISBN: 978-1-68392-516-3.
3.	Machine Learning ,Tom M. Mitchell, Indian Edition, 2013, McGraw Hill Education, ISBN – 10 – 1259096955
4.	Introduction to Data Mining ,Pang-Ning Tan, Michael Steinbach, Vipin Kumar,2nd Edition, 2019,Pearson , ISBN-10-9332571406, ISBN-13 -978-9332571402

RUBRICFOR 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) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+LAB)	**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 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**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: V						
NATURAL LANGUAGE PROCESSING AND TRANSFORMERS **Category: PROFESSIONAL CORE COURSE** **(Theory and Practice)**						
Course Code	**:**	**21AI53**		**CIE**	**:**	**100+50 Marks**
Credits: L: T: P	**:**	**3:0:1**		**SEE**	**:**	**100 +50 Marks**
Total Hours	**:**	**45T + 30L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**9 Hrs.**
Introduction to NLP: NLP in the Real-world, NLP Tasks, what is Language: Building Blocks of Language, Why NLP is Challenging, Machine Learning, Deep Learning, and NLP: An Overview, Approaches to NLP: Heuristic-based NLP, Machine Learning for NLP, Deep Learning for NLP, Why Deep Learning is not Yet the Silver Bullet for NLP, An NLP Walkthrough: Conversational Agents **NLP Pipeline:** Data Acquisition, Text Extraction and Cleanup: HTML Parsing and Cleanup, Unicode Normalization, Spelling Correction, System-Specific Error Correction, Pre-Processing: Preliminaries, Frequent Steps, Other Pre-Processing Steps, Advanced Processing	
Unit – II	**9Hrs.**
Tokenizing Text and WordNet Basics: Introduction, Tokenizing text into sentences, Tokenizing sentences into words, Tokenizing sentences using regular expressions, training a sentence tokenizer, Filtering stop words in a tokenized sentence Looking up Synsets for a word in WordNet, looking up lemmas and synonyms in WordNet, Calculating WordNet Synset similarity, Discovering word collocations. **Replacing and Correcting Words:** Introduction, stemming words, Lemmatizing words with WordNet, replacing words matching regular expressions, removing repeating characters, Spelling correction with Enchant, replacing synonyms, Replacing negations with antonyms	
Unit –III	**9Hrs.**
Creating Custom Corpora: Introduction, setting up a custom corpus, creating a wordlist corpus, creating a part-of-speech tagged word corpus, creating a chunked phrase corpus, creating a categorized text corpus, creating a categorized chunk corpus reader, Lazy corpus loading, creating a custom corpus view, creating a MongoDB-backed corpus reader, Corpus editing with file locking **Part-of-speech Tagging:** Default tagging, training a unigram part-of-speech tagger, combining taggers with backoff tagging, Training and combining n-gram taggers, creating a model of likely word tags, tagging with regular expressions, Affix tagging, training a Brill tagger, Training the TnT tagger, Using WordNet for tagging, tagging proper names, Classifier-based tagging, Training a tagger with NLTK-Trainer	
Unit –IV	**9Hrs.**
Transformers Basics The Encoder-Decoder Framework, Attention Mechanisms, Transfer Learning in NLP, Hugging Face Transformers: Bridging the Gap, A Tour of Transformer Applications: Text Classification, Named Entity Recognition, Question Answering, Summarization, Translation, Text Generation, The Hugging Face Ecosystem: The Hugging Face Hub, Hugging Face Tokenizers, Hugging Face Datasets, Hugging Face Accelerate, Main Challenges with Transformers. **Text Classification** The Dataset: A First Look at Hugging Face Datasets, From Datasets to Data Frames, looking at the Class Distribution, How Long Are Our Tweets? From Text to Tokens: Character Tokenization, Word Tokenization, Sub-word Tokenization, Tokenizing the Whole Dataset, Training a Text Classifier: Transformers as Feature Extractors, Fine-Tuning Transformers	

Unit –V	9Hrs
Transformer Anatomy The Transformer Architecture, The Encoder: Self-Attention, The Feed-Forward Layer, Adding Layer, Normalization, Positional Embeddings, adding a Classification Head, The Decoder, Meet the Transformers: The Transformer Tree of Life, The Encoder Branch, The Decoder Branch, The Encoder-Decoder Branch **Text Generation** The Challenge with Generating Coherent Text, Greedy Search Decoding, Beam Search Decoding, Sampling Methods, Top-k and Nucleus Sampling **Summarization** Text Summarization Pipelines, Summarization Baseline: GPT-2, T5, BART, PEGASUS	

PART-A	
Sl. No	• **Implement the following application of Natural Language Processing** • **Demonstrate the working of the programs by considering appropriate datasets**
1	**Text Summarization:** Text summarization refers to the technique of shortening long pieces of text. The intention is to create a coherent and fluent summary having only the main points outlined in the document.
2	**World Cloud:** A word cloud is a collection, or cluster, of words depicted in different sizes. The bigger and bolder the word appears, the more often it's mentioned within a given text and the more important it is.
3	**Sentiment Analysis:** Sentiment analysis is the process of analyzing digital text to determine if the emotional tone of the message is positive, negative, or neutral.
4	**Topic Modelling:** Topic modeling is an unsupervised machine learning approach that can scan a series of documents, find word and phrase patterns within them, and automatically cluster word groupings and related expressions that best represent the set.

PART-B

Open ended NLP and Transformers based project should be carried out in a team of two students, belongs to same batch of the laboratory.

General Guidelines for the project

- The topic of the project should be from application domains of NLP in DigiHealth, FinTech, EduTech, AgriTech ,etc. in consultation with the faculty in charge
- Coming up with the patentable ideas in language modelling and application is highly encouraged
- Presenting/publishing the paper in a reputed IEEE/ACM conferences/ Journal with good indexing like SCI, Scopus, and others attract higher marks in CIE.
- The student needs to submit both hard & soft copy of the report for evaluation.
- All the batches must adhere to the guidelines released time to time by the Lab coordinators, and submit all the proofs asked in support of the project

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Discuss various concepts, architectures and frameworks of NLP
CO2	Proficiency in utilizing the core and popular NLP libraries to provide solutions to real-world applications in Healthcare, Smart Cities, Agriculture, etc
CO3	Design and Develop agents that use Transformers for natural language understanding and generation
CO4	Demonstrate the use of modern tools in solving day-to-day problems by exhibiting teamwork through oral presentations and reports
CO5	Collaborate in a group to build NLP solutions for the benefit of society

Reference Books	
1.	Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta & Harshit Surana ,1st Edition, 2020, O'Reilly, ISBN: 978-1-492-05405-4
2.	Python 3 Text Processing with NLTK 3 Cookbook, Jacob Perkins 2014, 1st Edition, Packt Publishing, ISBN 978-1-78216-785-3
3.	Natural Language Processing with Transformers: Building Language Applications with Hugging Fac,Lewis Tunstall, Leandro von Werra, and Thomas Wolf, 2022, 1st Edition, O'Reilly Media, ISBN: 978-1-098-10324-8

RUBRICFOR 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) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks),lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+LAB)	**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 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**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: V						
CLOUD COMPUTING AND ARCHITECTURES **Category: PROFESSIONAL CORE COURSE** **(Theory)**						
Course Code	**:**	**21AI54**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:1:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L + 30T**		**SEE Duration**	**:**	**3.00 Hours**

UNIT-I	**8 Hrs**
Vision of Cloud Computing, Defining a Cloud, Cloud Computing Reference Model, Characteristics and Benefits, Historical Developments, Building Cloud Computing Environments, Computing Platforms and Technologies, Eras of Computing, Parallel vs. Distributed Computing, Elements of Distributed Computing.	
UNIT-II	**9 Hrs**
Virtualization and Cloud Architecture Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples, Xen, VMware, Microsoft Hyper-V, Cloud Reference Model and Architecture, Infrastructure as a Service, Platform as a Service, Software as a Service, Types of Clouds, Economics of the Cloud, Open Challenges in Clouds.	
UNIT-III	**9 Hrs**
Data-Intensive Computing: What is data-intensive computing? Characterising data-intensive computations, Challenges ahead, Historical perspective, Technologies for data-intensive computing – Storage systems, Programming platforms - MapReduce. **Public Cloud Infrastructures:** Amazon Web Services - Compute, Storage, and Communication Services; Google AppEngine – Architecture, Application Life-Cycle, Cost Model; and Microsoft Azure.	
UNIT-IV	**10 Hrs**
Introduction to Multi-Cloud: Introduction to Multi-Cloud, setting out a real strategy for multi-cloud, Analysing the enterprise strategy for the cloud, Introducing the scaffold for multi-cloud environments, Understanding identities and roles in the cloud. **Enterprise Cloud Architecture:** Defining architecture principles for multi-cloud, using quality attributes in architecture, Defining principles from use cases-Business principles, Business principles, Principles for security and compliance, Data principles, Application principles, Infrastructure and technology principles, Principles for processes	
UNIT-V	**9 Hrs**
Developing for Multi-Cloud with DevOps and DevSecOps,: Introducing DevOps and CI/CD Getting started with CI/CD , Working under version control Using push and pull principles in CI Pushing the code directly to the main branch, Pushing code to forks of the main, Best practices for working with CI/CD. Using the DevSecOps Maturity Model, Manage traceability and auditability , Automating security best practices using frameworks **Introducing AIOps and GreenOps in Multi-Cloud:** Understanding the concept of AIOps, Optimizing cloud environments using AIOps, Exploring AIOps tools for multi-cloud, Introducing GreenOps	

CO1	Explain the concepts of cloud computing, models, infrastructure, services, distributed computing, and other related concepts.
CO2	Apply the virtualization concepts and study the working of various service models, PAAS, SAAS, and IAAS.
CO3	Demonstrate various use cases of Multi-cloud and Enterprise cloud computing.
CO4	Analyze various cloud programming models and apply them to solve real-world problems.
CO5	Demonstrate critical, innovative thinking and display competence in oral, written, and visual communication.

Reference Books	
1.	Thomas Erl Thomas Erl_ Zaigham Mahmood_ Ricardo Puttini ,Cloud Computing_ Concepts, Technology & Architecture,2013,Prentice Hall
2.	Jeroen Mulder ,Multi-Cloud Strategy for Cloud Architects_ Learn how to adopt and manage public clouds by leveraging BaseOps, FinOps, and DevSecOps,2nd Edition,2023,Packt Publishing (2023)
3.	Distributed Computing and Cloud Computing, from parallel processing to internet of things ,Kai Hwang, GeofferyC.Fox, Jack J Dongarra ,1st Edition, 2012, Elsevier, ISBN: 978-0-12-385880-1.
4.	Cloud Computing Implementation, Management and Security .John W Rittinghouse, James F Ransome,, 1st Edition, 2013, CRC Press, ISBN: 978-1-4398-0680-7.

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)	
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: V					
INFORMATION RETRIEVAL SYSTEMS **Category : Professional Core Elective** **(Theory)**					
Course Code	**:**	**21AI55B1**	**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**	**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**	**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**
Introduction to information retrieval and architecture of a search engine-Search Engines and Information Retrieval- What Is Information Retrieval? The Big Issues, Search Engines, Search Engineers **Architecture of a Search Engine-** What is architecture? Basic Building Blocks, Breaking It Down	
Unit – II	**09 Hrs**
Crawls and Feeds- Deciding what to search, Crawling the Web, Crawling Documents and Email, Document Feeds, The Conversion Problem, Storing the Documents, Detecting Duplicates, Removing Noise **Processing Text –** From words to text, Text Statistics, Document Parsing, Document Structure and Markup, Link Analysis, Information Extraction	
Unit – III	**09 Hrs**
Ranking with Indexes - Overview, Abstract Model of Ranking, Inverted indexes, Compression, Auxiliary Structures, Index Construction, Query Processing	
Unit – IV	**09 Hrs**
Queries and Interfaces- Information Needs and Queries, Query Transformation and Refinement, Showing the Results, Cross-Language Search	
Unit – V	**09 Hrs**
Retrieval Models - Overview of Retrieval Models , Probabilistic Models, Ranking Based on Language Models **Evaluating Search Engines-** Why Evaluate? The Evaluation Corpus, Effectiveness Metrics, Efficiency Metrics	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand and apply Information Retrieval principles to extract relevant information from the given problem
CO2	Analyze the different Information Retrieval techniques, retrieval models and search engines appropriate for a given problem by engaging in lifelong learning for emerging technology
CO3	Exhibit effective communication to solve open problems using Information Retrieval principles to extract the information from different models
CO4	Demonstrate solutions using concepts of Information Retrieval by exhibiting team work and effective communication
CO5	Examine the applications of Information Retrieval principles using modern engineering tools for technological change

Reference Books	
1.	Search Engines: Information Retrieval in Practice Kindle ,Trevor Strohman, Bruce Croft Donald Metzler ,2015, Pearson Education Inc., ISBN-13: 978-0136072249
2.	Introduction to Information Retrieval,Christopher D. Manning, Prabhakar, Raghavan and Hinrich Schutze,", 2008, Cambridge University Press, ISBN 978-0-521-86571-5

3.	Information Retrieval Data Structures and Algorithms ,William B Frakes, Ricardo Baeza-Yates ,3rd Edition, 2009, Pearson Education, ISBN13: 9780134638379
4.	Information Storage & Retrieval ,Robert. R. Korfhage ,4th Edition, 1997, John Wiley & Sons, Inc. New York, NY, USA, ISBN:0-471-14338-3

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). 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)	
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: V						
EXTENDED REALITY **Category: Professional Core Electives** **(Theory)**						
Course Code	**:**	**21AI55B2**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**7 Hrs**
Introduction: What is Virtual Reality? Four Key Elements of Virtual Reality Experience. Virtual Reality Hardware: Oculus Rift, Other High-End Head Mounted Displays, Gear VR, Google Cardboard, VR Input Devices. **VR The Medium**: Communicating Through a Medium, Common Issues of Human Communication Media, Narrative, Immobile Versus Interactive.	
Unit – II	**10 Hrs**
Interface to the Virtual World-Input: User Monitoring (User Input to the Virtual World) Position Tracking Body Tracking Other Physical Input Devices World Monitoring (Dynamic Input to the Virtual World) Persistent Virtual Worlds Bringing the Real World into the Virtual World. **Interface to the Virtual World-Output** Visual Displays Visual Depth Cues Properties of Visual Displays Monitor-based--or Fishtank—VR Projection-based VR Head-based VR See-through Head-based Displays Handheld VR Paradigms Aural Displays Aural Localization Cues Properties of Aural Displays Head-based Aural Displays—Headphones Stationary Aural Displays—Speakers Combining Aural Display Systems	
Unit –III	**10 Hrs**
Modeling Tools for VR: An introduction to Blender. Modeling of an object, object Animation, Animating a full sequence. **Rendering the Virtual World:** Visual Representation in VR, Aural Representation in VR, Haptic Representation in VR, Visual Rendering Systems, Aural Rendering Systems, Haptic Rendering Systems, Importing from Blender to Unity.	
Unit -IV	**10 Hrs**
Introduction to Augmented Reality: Definition and scope, Mixed Reality, Applications of AR & MR Tracking: Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion. **Computer Vision for Augmented Reality:** Marker-based tracking, Marker-less tracking	
Unit -V	**8 Hrs**
Introduction to WebXR: Entering VR through WebXR, Life cycle of WebXR application, Creating an XR session through WebXR. Creating an AR website with WebXR: Object creation, spatial tracking, start AR session. **Creating an AR website with WebXR**: Object creation, spatial tracking, start AR session, animate, create an event handling function for the end of the session.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the need for Virtual Reality and Augmented Reality for developing Human Computer Interactions.
CO2:	Work with interfaces for virtual world input and output and identify potential engineering applications for extended reality
CO3:	Use modern tools to design and develop real-world applications using extended reality
CO4:	Create use cases for virtual reality and augmented reality devices in compatible web browsers using web application programming interfaces
CO5:	Work in teams to develop solutions using Extended reality useful to society and industry

Reference Books	
1	Understanding Virtual Reality ,William R. Sherman, Alan B. Craig , 2003, Morgan Kaufmann Publishers, ISBN: 1-5586o-353-0
2	Blender 3D: Designing Objects, Romain Caudron, Pierre-Armand Nicq, Enrico Valenza, 2016, Packt Publishing Ltd, ISBN 978-1-78712-719-7
3	Creating Augmented and Virtual Realities Theory & Practice for Next-Generation Spatial Computing Alan B Craig, William R Sherman and Jeffrey D Will , O'REILLY 2019 3.
4	AR and VR Using the WebXR API, Rakesh Baruah , 2021, ISBN-13 : 978-1-4842-6317- 4 ISBN-13 : 978-1-4842-6318-1 https://doi.org/10.1007/978-1-4842-6318-1

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). 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)	
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: V						
INTERNET OF THINGS AND COMPUTING PARADIGMS **Category: Professional Core Electives** **(Theory)**						
Course Code	**:**	**21AI55B3**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**9 Hrs.**
Predecessors of IoT Introduction, Wireless Sensor Networks, Machine to machine Communications **Emergence of IoT** Introduction, Evolution of IoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components, Addressing Strategies in IoT	
Unit – II	**9 Hrs.**
IoT Connectivity Technologies Introduction, IEEE 802.15.4, Zigbee, Thread, ISA100.11A, Wireless HART, RFID, NFC, Sigfox, LoRa, NB-IoT, Wi-Fi, Bluetooth **IoT Communication Technologies-I** Introduction, Identification Protocols: EPC, uCode, URIs, Device Management: TR-069, OMA-DM, Standards: EnOcean, DLNA, Konnex, UPnP, LonWorks, Insteon, X-20	
Unit –III	**9 Hrs.**
IoT Communication Technologies-II Discovery Protocols: Physical Web, Multicast DNS (mDNS), Universal plug and Play (UPnP) Data Protocols: MQQT, MQTT-SN, CoAP, AMQP, XMPP, SOAP, REST, WebSocket, Semantic Protocols: JSON-LD, Web thing model	
Unit –IV	**9 Hrs.**
Introduction to Computing Introduction to Computing, The Major Impacts of Computing, Parallel Computing, Distributed Computing, Cluster Computing, utility Computing, Grid Computing, Cloud Computing, Other Computing Paradigms **Fog Computing and Its Applications** Introduction, View of a Fog Computing Architecture, Fog Computing in IoT, elected Applications of Fog Computing	
Unit –V	**9Hrs**
Edge Computing and Its Essentials Introduction, Edge Computing Architecture: Edge Devices, Edge Server Cluster, Cloud Server, Background Essentials: IoT Devices, Mobile-Based Sensors, Medical Sensors, Neural Sensors, Environmental Sensors, Radio Frequency Identification, Networking Architecture, Edge Computing State-of the-Art Interfaces and Devices: Middleware, Application Interfaces	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the concepts and components of the Internet of Things (IoT) technology
CO2	Study various communication and messaging protocols for IoT devices and identify some real-world applications for IoT
CO3	Analyze and compare the different computing paradigms to develop better IoT solutions
CO4	Demonstrate proficiency in IoT and related technologies using modern tools through oral presentations and reports
CO5	Collaborate in a group to build IoT solutions for the benefit of society

Reference Books	
1	Introduction to IoT, Sudip Misra, Anandarup Mukherjee and Arijit Roy,1st Edition, Cambridge University Press, 2020, ISBN 978-1-108-84295-2, ISBN 978-1-108-95974-2.
2	Edge Computing: Fundamentals, Advances and Applications, K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, M. Niranjanamurthy, CRC Press, 1st Edition, 2022, ISBN: 978-1-032-12608-1, ISBN: 978-1-032-13821-3, ISBN: 978-1-003-23094-6.
3.	Adrian McEwen, Hakim Cassimally - Designing the Internet of Things, Wiley,1st Edition,2013, ISBN-10 : 111843062X ,ISBN-13 : 978-1118430620
4.	Dawid Borycki - Programming for the Internet of Things PHI Learning Pvt.Ltd,Microsoft Press,2019,ISBN-10 : 9387472558 ,ISBN-13 : 978-9387472556

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	
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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: V						
DISTRIBUTED AND PARALLEL COMPUTING **Category: Professional Core Electives** **(Theory)**						
Course Code	**:**	**21AI55B4**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**9 Hrs.**
Introduction to Distributed and Parallel Computing **Introduction to Distributed Computing** – Introduction ,Definition, Goals of Distributed systems, Issues to Distributed systems , Types of Distributed Systems , Distributed System Models , Models of Middle ware **Introduction to Parallel Computing** – Introduction ,Computing , Parallel Architecture , Classification based on architectural scheme , Classification based on Memory access , Performance Metrics ,Parallel Programming models, Serial and Parallel Algorithms, Parallelism	
Unit – II	**9 Hrs.**
Communication and Resource Management (Distributed Computing) **Communication :** Introduction , Layered protocols , Remote Procedure Calls , Remote Object Invocation , Remote Method Invocation , Message Oriented Communications , Stream Oriented Communications **Resource Management :** Resource management in Distributed system ,Desirable Features of Global Scheduling algorithm **,** Scheduling in Distributed system **,** Load Balancing approach in distributed system , Load Sharing Approach	
Unit –III	**9 Hrs.**
Synchronization , Replication and Distributed File System (Distributed Computing) Introduction ,Clock Synchronization , Physical clock , Logical clock , Election Algorithms , Mutual Exclusion , Centralized algorithm , Distributed Mutual Exclusion **Replication and Distributed File System** Replication Management ,Distributed File system ,Case studies	
Unit –IV	**9 Hrs.**
Distributed Memory Programming with MPI (Parallel Computing) Getting Started , Trapezoidal Rule in MPI ,Dealing with I/O, Collective Communication , MPI Derived data types ,Performance Evaluation of MPI programs , A parallel sorting algorithm	
Unit –V	**9 Hrs**
Shared Memory programming with Open MP(Parallel Computing) Getting Started , Trapezoidal Rule , Scope of Variables , Reduction Clause – Parallel for directive , More about Loops in open , Scheduling loops	

Reference Books	
CO1	Understand and realize the need of distributed and parallel computing systems and techniques
CO2	Apply different management techniques to handle distributed and parallel mechanism
CO3	Analyze and summarize the concepts of distributed and parallel computing mechanisms by engaging in life long learning
CO4	Exhibit concepts of distributed and parallel computing concepts though effective communication in continuing professional development
CO5	Demonstrate the metrics and performance of distributed and parallel programs as an individual or working in team

Reference Books	
1	Parallel and Distributed Systems ,Arun Kulkarni, Nupur Prasad Giri, Nikeshi Joshi, Bhushan Jadhav, 2nd Edition, 2017,Wiley Publication, ISBN: 978-81-265-6582-5
2	An Introduction to Parallel Programming ,Peter S Pacheco ,2014,Morgan Kaufmann Publishers – ISBN : 978-93-80931-75-3
3	Distributed Computing ,Sunita Mahajan and Seema Shah, 2nd Edition, Oxford University Press, ISBN-10: 0198093489, ISBN-13: 9780198093480
4	Parallel and Distributed Computing Handbook ,Albert Y. Zomaya, Editor,McGraw-Hill, ISBN-13: 978-0070730205 , ISBN-10: 0070730202

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**
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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**
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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: V						
INFORMATION SECURITY - 5 - SECURE SYSTEMS ENGINEERING **Category: PROFESIONAL ELECTIVE** **(Theory)**						
Course Code	**:**	**21CS56C1**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30L**		**SEE Duration**	**:**	**3Hours**
Unit-I						**10 Hrs**
Introduction/gdb/buffer overflow, Preventing buffer overflow based malware, Integer overflow and buffer over read and heap overflow.						
Unit – II						**10 Hrs**
More on heap overflow; Access Control, Confinement, SGX, and Trustzone						
Unit –III						**10 Hrs**
Micro-architectural Attacks, Hardware Security.						

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the significance of security measures in preventing attacks.
CO2	Compare various security mechanisms in preventing attacks.
CO3	Identify the risks associated with software security
CO4	Analyze micro-architectural attacks and their impact on system security.

Reference Books	
1.	Chester Rebeiro, Information Security - 5 - Secure Systems Engineering, 106106199.pdf - Google Drive
2.	Rose J Anderson, Security Engineering: A Guide to Building Dependable Distributed Systems ,2nd edition, April 14, 2008 by Wiley
3.	Mark Merkow, INFORMATION SECURITY : PRINCIPLES AND PRACTICES, 1st EDITION, Pearson India

Semester: V						
DESIGN, TECHNOLOGY AND INNOVATION **Category: PROFESIONAL ELECTIVE** **(Theory)**						
Course Code	**:**	**21ME56C2**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30L**		**SEE Duration**	**:**	**3Hours**
Unit-I						**10 Hrs**
Jaipur Foot - A classic innovation, User Centred Helmet Design, Challenges of Reaching a Million Users						
Unit – II						**10 Hrs**
Technology to Solution, Collaborative Excellence, Collaborative Innovation Methods, Learnings from Grassroot Innovation						
Unit –III						**10 Hrs**
Systemic Approach to Biomed Innovations, Research to Innovation , Smartcane for the Blind- A Success Story						

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the significance of innovation in the digital era.
CO2	Build creative solutions independently and collaboratively within teams to optimize business outcomes.
CO3	Develop the ability to design and evaluate customer-centric, inventive prototypes.
CO4	Analyze strategies for implementing biomed innovations into real-world scenarios.

Reference Books	
1.	B. K. Chakravarthy, Design, Technology and Innovation, https://calibr.ai/book/design-technology-and-innovation
2.	B. K. Chakravarthy, Design, Technology and Innovation, http://www.idc.iitb.ac.in/~chakku/COLLABORATIVE_MODEL_FOR_INNOVATION.pdf

Semester: V						
SYSTEMS ENGINEERING: THEORY & PRACTICE **Category: PROFESIONAL ELECTIVE** **(Theory)**						
Course Code	**:**	**21AI56C3**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**10 Hrs**
Systems engineering – what is, origin, and examples, Systems engg as a profession, Power of systems engg and examples, Systems engg viewpoint, perspectives, domains, Systems engg fields, approaches, activities, and products, Complex system structure-building blocks, hierarchy, interfaces, Complex system structure-environment, interactions, complexity, System development process – life cycle, evolutionary characteristics, Systems engg method, Systems testing throughout development, Managing systems development, risks, work breakdown structure (WBS), systems engg management plan (SEMP), Systems risk management, organizing for systems engg, Need analysis – originating, operations, functional, and feasibility, Need validation, systems ops requirement, System requirements development, performance requirements.	
Unit – II	**10 Hrs**
Implementing concept exploration, validating requirements, Concept definition – selection and validation, functional analysis and allocation, Systems architecture, system modeling languages, Model-Based Systems Engg (MBSE), Decision making, modeling for decisions, Simulation, Trade-off analysis, Engg development stage – program risk reduction, prototype development for risk mitigation, Development testing, risk reduction, Revision of functional analysis and design, Overview of probability data analysis, Hypothesis testing, Engineering design – implementing system building blocks, component design, Design validation, change management, Concepts of reliability, redundancy, Concepts of maintainability, availability, producibility, User interface design, and GUI.	
Unit –III	**10 Hrs**
Integration, testing, and evaluating the total system, Test planning, and preparation, system integration, Developmental and operational test and evaluation, Engineering for production, transition from development to production, Production operations – 1, Production operations – 2, Installation, maintenance, and upgrading, Installation testing, In-service support, Upgrades and modernization.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the concept of systems engineering and its development process.
CO2	Compare various design stages and their implications in system development.
CO3	Design and implement system architectures using modeling languages.
CO4	Analyze production operations and support activities for continuous improvement in system functionality and usability.

Reference Books	
1.	Systems Engineering Second ed. – Kossiakoff, A., Sweet, W.N., Seymour, S.J., and Biemer S.M., John Wiley Sons Inc., New Jersey, 2011
2.	International Council of Systems Engineering, Systems Engineering Handbook, A guide for System Life Cycle Processes and Activities, version 3.2.1, January 2011.
3.	Systems Engineering Fundamentals, Department of Defense, Defense Acquisition University, Systems Engineering Fundamentals, 2001.

Semester: V						
EDGE COMPUTING **Category: PROFESIONAL ELECTIVE** **(Theory)**						
Course Code	**:**	**21AI56C4**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**10 Hrs**
Introduction to Cloud and its limitations to support low latency and RTT. From Cloud to Edge Computing: Waves of Innovation, Introduction to Edge Computing Architectures, Edge Computing to Support User Applications (5G-Slicing, self-driving cars and more).	
Unit – II	**10 Hrs**
Concepts of distributed systems in edge computing such as time ordering and clock synchronization, distributed snapshot, etc., Introduction to Edge Data Centers, Lightweight Edge Clouds and its services provided by different service providers., Introduction to docker container and Kubernetes in edge computing. Design of edge storage systems like key-value stores.	
Unit –III	**10 Hrs**
Introduction to MQTT and Kafka for end-to-end edge pipeline. Edge analytics topologies for M2M and WSN network (MQTT), Use cases of machine learning for edge sensor data in predictive maintenance, image classifier, and self-driving cars. Deep Learning On-Device inference at the edge to support the latency-based application.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand how cloud computing environments can be scaled to workloads.
CO2	Develop mechanisms for distributing information and processing in an edge-cloud-environment
CO3	Apply ML and DL frameworks suitable for edge computing.
CO4	Design and develop system architecture for edge computing

Reference Books	
1.	"Fog and Edge Computing: Principles and Paradigms", Rajkumar Buyya (Editor), Satish Narayana Srirama (Editor), Wiley, 2019
2.	Cloud Computing: Principles and Paradigms", Editors: Rajkumar Buyya, James Broberg,Andrzej M. Goscinski, Wiley, 2011
3.	"Cloud and Distributed Computing: Algorithms and Systems", Rajiv Misra, Yashwant Patel, Wiley 2020.

Semester: V						
SUMMER INTERNSHIP-II (Practical)						
Course Code	**:**	**21AII57**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:00:02**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**4 Weeks**		**SEE Duration**	**:**	**2.00 Hrs**

1. A minimum of 1 credit of internship after I year may be counted towards B.E. degree program.
2. During II semester to III semester transition, Three weeks of internship is mandatory.
3. Internship report and certificate need to be submitted at the end of the internship to the concerned department for the evaluation.
4. Internship evaluation will be done during V semester for 2 credit in two phases.

Students can opt the internship with the below options	**04 Weeks**

A. Within the respective department at RVCE (Inhouse)
Departments may offer internship opportunities to the students through the available tools so that the students come out with the solutions to the relevant societal problems that could be completed within FOUR WEEKS.

B. At RVCE Center of Excellence/Competence
RVCE hosts around 16 CENTER OP EIXCELLENCE in various domains and around 05 CENTER OP COMPETENCE. The details of these could be obtained by visiting the website https:/ /rvce.edu.in / rvce-center-excellence. Each center would be providing the students relevant training/internship that could be completed in three weeks.

C. At Intern Shala
Intern Shala is India's no.1 internship and training platform with 40000+ paid internships in Engineering. Students can opt any internship for the duration of three weeks by enrolling on to the platform through https: / /internsha1a.com

D. At Engineering Colleges nearby their hometown
Students who are residing out of Bangalore, should take permission from the nearing Engineering College of their hometown to do the internship. The nearby college should agree to give the certificate and the letter/email stating the name of the student along with the title of the internship held with the duration of the internship in their official letter head.

E. At Industry or Research Organizations
Students can opt for interning at the industry or research organizations like BEL, DRDO, ISRO, BHEL, etc. through personal contacts. However, the institute/industry should provide the letter of acceptance through hard copy/email with clear mention of the title of the work assigned along with the duration and the name of the student.

Procedures for the Internship:

1. Request letter/Email from the office of respective departments should go to Places where internships are intended to be carried out with a clear mention of the duration of Three Weeks. Colleges/Industry/ CoEs/CoCs will confirm the training slots and the number of seats allotted for the internship via confirmation letter/ Email.
2. Students should submit a synopsis of the proposed work to be done during internship program. Internship synopsis should be assessed or evaluated by the concerned Colleges/Industry/CoEs/CoC. Students on joining internship at the concerned Colleges/Industry/ CoEs/CoCs submit the Daily log of student's dairy from the joining date.
3. Students will submit the digital poster of the training module/project after completion of internship.
4. Training certificate to be obtained from industry.

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Develop communication, interpersonal,critical skills, work habits and attitudes necessary for employment.
CO2	Assess interests, abilities in their field of study, integrate theory and practice and explore career opportunities prior to graduation.
CO3	Explore and use state of art modern engineering tools to solve societal problems with affinity towards the environment and involve in professional ethical practice.
CO4	Compile, document and communicate effectively on the internship activities with the engineering community.

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**REVIEW I:** Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments, exhibiting professional and ethical practice, communication skills (oral and body language).	**20**
2.	**REVIEW II**: Presentation in the form digital poster, report writing, exhibiting ethics in report writing, oral presentation.	**30**
MAXIMUM MARKS FOR THE CIE		**50**

RUBRICS FOR SEMESTER END EXAMINATION		
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner.		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	**10**
2	Conduction of the Experiments	**20**
3	Viva	**20**
	TOTAL	**50**

Semester: V/VI						
PRINCIPLES OF MANAGEMENT & ECONOMICS (Common to all Programs) (Theory)						
Course Code	**:**	**21HS61B**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**06 Hrs**
Introduction to Management: Management Functions – POSDCORB – an overview, Management levels & Skills, Management History - **Classical Approach:** Scientific Management, Administrative Theory, **Quantitative Approach:** Operations Research, **Behavioral Approach:** Hawthorne Studies, **Contemporary Approach:** Systems Theory, Contingency Theory. **Caselets / Case studies**	
Unit – II	**10 Hrs**
Foundations of Planning: Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate strategies – types of corporate strategies, BCG matrix, Competitive Strategies – Porters Five force Model, types of Competitive Strategies. **Caselets / Case studies Organizational Structure & Design:** Overview of Designing Organizational Structure - Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures. **Caselets / Case studies**	
Unit –III	**10 Hrs**
Motivation: Early Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Theory Y, Herzberg's Two Factor Theory. Contemporary Theories of Motivation: Adam's Equity theory, Vroom's Expectancy Theory. **Caselets / Case studies** **Leadership:** Behavioral Theories: Blake & Mouton's Managerial Grid, Contingency Theories of Leadership: Hersey & Blanchard's Situational Leadership, Contemporary Views of Leadership: Transactional & Transformational Leadership. **Caselets / Case studies**	
Unit –IV	**10 Hrs**
Introduction to Economics: Microeconomics and Macroeconomics, Circular flow model of economics, An Overview of Economic Systems. **Macroeconomic models**- The classical growth theory, Keynesian cross model, IS-LM-model, The AS-AD model, The complete Keynesian model, The neo-classical synthesis. National Budgeting process in India. **Macroeconomic Indicators:** Prices and inflation, Consumer Price Index, Exchange rate, Labor Market, Money and banks, Interest rate. Gross Domestic product (GDP) - components of GDP, Measures of GDP: Outcome Method, Income method and Expenditure method, Numericals on GDP Calculations.	
Unit –V	**09 Hrs**
Essentials of Microeconomics: Demand, Supply, and Equilibrium in Markets for Goods and Services, Price Elasticity of Demand and Price Elasticity of Supply, Elasticity and Pricing, Numericals on determining price elasticity of demand and supply. Changes in Income and Prices Affecting Consumption Choices, Monopolistic Competition, Oligopoly.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Elucidate the principles of management theory & recognize the characteristics of an organization.
CO2	Demonstrate the importance of key performance areas in strategic management and design appropriate organizational structures and possess an ability to conceive various organizational dynamics.
CO3	Compare and contrast early and contemporary theories of motivation and select and implement the right leadership practices in organizations that would enable systems orientation.
CO4	Demonstrate an understanding on the usage and application of basic economic principles.
CO5	Appreciate the various measures of macro-economic performance and interpret the prevailing economic health of the nation.

Reference Books:	
1.	Management, Stephen Robbins, Mary Coulter & NeharikaVohra, 15th Edition, 2021, Pearson Education Publications, ISBN: 13: 978-0-13-558185-8
2.	Management, James Stoner, Edward Freeman & Daniel Gilbert Jr, 6th Edition, 2009, PHI, ISBN: 81-203-0981-2.
3.	Principles of Microeconomics, Steven A. Greenlaw, David Shapiro, 2nd Edition, 2017, ISBN:978-1-947172-34-0
4.	Macroeconomics: Theory and Policy, Dwivedi D.N, 5th Edition, 2021, McGraw Hill Education; ISBN : 9789353163334

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 1500 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
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
BIG DATA TECHNOLOGIES **Category: PROFESSIONAL CORE COURSE** **(Theory & Lab)**						
Course Code	**:**	**21AI62**		**CIE**	**:**	**100 +50Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3 Hours**

Unit – I	**09 Hrs**
The Hadoop Distributed File system **The Design of HDFS** - HDFS Concepts – Blocks, Name nodes and Data nodes, HDFS Federation, HDFS High Availability **Data Flow** – Anatomy of a File Read, Anatomy of a File Write	
Unit – II	**09 Hrs**
Map Reduce – Distributed Processing Framework- A Weather Dataset – Data format, Analysing the data with Unix Tools, Analyzing the Data with Hadoop – Java MapReduce, Scaling Out **Working of Map Reduce -** Anatomy of a Map Reduce Job Run, Failures, Shuffle and Sort, Task Execution	
Unit –III	**09 Hrs**
Hive - Configuring Hive, Hive Services ,The Metastore **Comparison with Traditional Databases** -Schema on Read Versus Schema on Write,Updates, Transactions, and Indexes ,SQL-on-Hadoop Alternatives **HiveQL** - Data Types, Operators and Functions **Tables** -Managed Tables and External Tables, Partitions and Buckets, Storage Formats, Importing Data, Altering Tables, Dropping Tables, **Querying Data** -Sorting and Aggregating, MapReduce Scripts,Joins, Subqueries,Views	
Unit –IV	**09 Hrs**
Flume - Installing Flume, **Transactions and Reliability** -Batching ,**The HDFS Sink** -Partitioning and Interceptors File Formats **Fan Out**-Delivery Guarantees, Replicating and Multiplexing Selectors **Distribution: Agent Tiers**-,Delivery Guarantees, **Sink Groups** - Integrating Flume with Applications, Component Catalog	

Unit –V	**09Hrs**
Spark Applications- Jobs, Stages, and Tasks, A Scala Standalone Application, **Resilient Distributed Datasets** - Creation, Transformations and Actions, Persistence, Serialization **Shared Variables** -Broadcast Variables, Accumulators **Anatomy of a Spark Job Run** - Job Submission, DAG Construction, Task Scheduling, Task Execution	

Lab Component	
Expt. No	**Programs**
1.	**Map Reduce Program on Counting** a) Write a Java Program using Mapper and Reducer function to find the number of records in the give dataset b) Submit the job to cluster c) Track the job information
2.	**Map Reduce Program using Temperature Dataset** 1. Write a Java program for finding Maximum recorded temperature by the year from Weather Dataset 2. Submit the job to cluster **3.** Find the status of the Job and terminate it
3.	**Programs on Pig Script Using movie lens data** a) List all the movies and the number of ratings b) List all the users who have rated the same movie and find the number of ratings c) List all the Users who have rated the movies (Users who have rated at least one movie) d) Find the count of the Movie which has the ratings more than 3 e) Find the max, min, average ratings for all the movie
4.	**Program on Advanced Concepts in Pig** a) Group by Year and dump the result in a bag b) Write a pig script to find the maximum temperature c) Write a pig Script to find the average temperature of a state for 3 years and store the result in HDFS
5.	**Extract facts using Hive on movie lens data** a) Write a query to select only those records which correspond to starting, browsing, completing, or purchasing movies. Use a CASE statement to transform the RECOMMENDED column into integers where 'Y' is 1 and 'N' is 0. Also, ensure GENREID is not null. Only include the first 25 rows. b) Write a query to select the customer ID, movie ID, recommended state and most recent rating for each movie.
PART - B	
Group of two students belongs to same batch are required to implement a problem statement which makes use of streaming data using Apache Spark. Examples: Identifying Credit Card Fraud, Identifying prospective customers on a commerce website, real-time stock trades, up-to-the minute inventory management, fake-news detection, etc.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand and apply the different building blocks of Big Data Technologies to a given problem
CO2	Articulate the programming aspect of Big Data Technologies to obtain solution to the problem through lifelong learning
CO3	Exhibit effective communication to represent the analytical aspects of Big Data Technologies for obtaining solution to the problems
CO4	Demonstrate solutions for societal and environmental concern problems using modern engineering tools through writing effective reports
CO5	Appraise the knowledge of Big Data Technologies as an Individual /as a team member

Reference Books	
1.	Tom White ,"Hadoop – The Definitive Guide; Storage and Analysis at Internet scale", , 4th Edition, 2015, O'Reilly, Shroff Publishers & Distributers Pvt. Ltd., ISBN – 978-93-5213-067-2
2.	DT Editorial Services "Big Data – Black Book" Dreamtech Press, Edition – 2015, ISBN - 978-93-511-9-757-7
3.	Dirk deRoos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss, "Hadoop for Dummies", 2014, John Wiley & Sons, Inc., ISBN: 978-1-118-60755-8 (pbk); ISBN 978-1-118-65220-6 (ebk); ISBN 978-1-118-70503-2 (ebk)
4.	Nathan Marz and James Warren,"Big Data Principles and best practices of scalable real-time data systems", April 2015, ISBN 9781617290343

RUBRICFOR 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) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+LAB)	**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 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**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: VI						
ARTIFICIAL NEURAL NETWORK AND DEEP LEARNING **Category: Professional Core Course** **(Theory & Lab)**						
Course Code	:	**21AI63**		**CIE Marks**	:	**100+50 Marks**
Credits: L: T:P	:	**3:0:1**		**SEE Marks**	:	**100+50 Marks**
Total Hours	:	**45L+30P**		**SEE Duration**	:	**3 Hours**

Unit – I	**9 Hrs**
Neural Networks: **Introduction:** What is a Neural Network? Models of a Neuron, Network Architectures **Learning Processes:** Error-correction learning, memory-based learning, Hebbian learning, Competitive learning and Boltzmann learning, Learning with a teacher, Learning without a teacher, Learning tasks, Memory and adaptation. Statistical Learning Theory, VC dimension	
Unit – II	**9 Hrs**
Single-layer Perceptron: Adaptive Filtering Problem, Unconstrained Optimization Techniques, Steepest Descent, Least-Mean-Square Algorithm, Learning Curves, Learning rate annealing techniques, Perceptron and Convergence theorem **Multilayer Perceptron:** Back-propagation Algorithm, Sequential and Batch Modes of training, Stopping Criteria, XOR problem, Heuristics for BP algorithm to perform better	
Unit – III	**10 Hrs**
Convolutional Neural Networks: **Introduction:** Historical Perspective and Biological Inspiration, Broader Observations About Convolutional Neural Networks **The Basic Structure of a Convolutional Network:** Padding, Strides, Typical Settings, The ReLU Layer, Pooling, Fully Connected Layers , The Interleaving Between Layers , Local Response Normalization , Hierarchical Feature Engineering **Training a Convolutional Network:** Backpropagating Through Convolutions , Backpropagation as Convolution with Inverted/Transposed Filter, Convolution/Backpropagation as Matrix Multiplications, Data Augmentation **Applications of Convolutional Networks:** Content-Based Image Retrieval , Object Localization, Object Detection , Natural Language and Sequence Learning , Video Classification	
Unit – IV	**10 Hrs**
Recurrent Neural Networks **Introduction**: Expressiveness of Recurrent Networks, **The Architecture of Recurrent Neural Networks**: Language Modeling Example of RNN, Generating a Language Sample, Backpropagation Through Time, Bidirectional Recurrent Networks, Multilayer Recurrent Networks **Echo-State Networks, Long Short-Term Memory (LSTM) , Gated Recurrent Units (GRUs)** **Applications of Recurrent Neural Networks:** Application to Automatic Image Captioning, Sequence-to-Sequence Learning and Machine Translation , Question-Answering Systems, Application to Sentence-Level Classification , Token-Level Classification with Linguistic Features, Time-Series Forecasting and Prediction, Temporal Recommender Systems, Secondary Protein Structure Prediction End-to-End Speech Recognition Handwriting Recognition	

Unit – V	10 Hrs

Deep Reinforcement Learning : Introduction
Stateless Algorithms: Multi-Armed Bandits: Naïve Algorithm, Greedy Algorithm, Upper Bounding Methods
The Basic Framework of Reinforcement Learning: Challenges of Reinforcement Learning, Simple Reinforcement Learning for Tic-Tac-Toe, Role of Deep Learning and a Straw-Man Algorithm
Bootstrapping for Value Function Learning: Deep Learning Models as Function Approximators, Example: Neural Network for Atari Setting, On-Policy Versus Off-Policy Methods: SARSA, Modeling States Versus State-Action Pairs
Monte Carlo Tree Search
Case Studies: AlphaGo: Championship Level Play at Go, Alpha Zero: Enhancements to Zero Human Knowledge , Self-Learning Robots, Deep Learning of Locomotion Skills, Deep Learning of Visuomotor Skills, Building Conversational Systems: Deep Learning for Chatbots, Self-Driving Cars

Laboratory Component

Group of two students belongs to same batch are required to implement an engineering application using any one of the deep learning techniques, CNN and architectures, RNN or Reinforcement learning.
Examples:
CNN: Biometric authentication using CNN, Object identification and recognition, Emotion recognition, Auto translation, document classification, etc.
RNN: Language translation, Generating image descriptions, Speech recognition, etc,
Reinforcement learning: Real-time bidding, Recommendation Systems, Traffic Control Systems, etc.

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Describe basic concepts of neural network, its applications and various learning models
CO2	Analyze different Network Architectures, learning tasks, convolutional networks, and deep learning models
CO3	Investigate and apply neural networks model and learning techniques to solve problems related to society and industry
CO4	Demonstrate a prototype application developed using any NN tools and APIs
CO5	Appraise the knowledge of Neural Networks and Deep Learning as an Individual /as a team member

Reference Books:	
1	Neural Networks – A Comprehensive Foundation ,Simon Haykin, 2nd Edition, PHI, 2005.
2	Neural Networks and Deep learning: A Textbook ,Charu C Aggarwal, Springer International Publishing AG, ISBN 978-3-319-94462-3 ISBN 978-3-319-94463-0 (eBook), https://doi.org/10.1007/978-3-319-94463-0, 2018
3	Deep Learning (Adaptive Computation and Machine Learning Series),,Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press (3 January 2017), ISBN-13: 978-0262035613.
4	Fundamentals of Artificial Neural Networks ,M H Hassoun, MIT Press, 2010, ISBN-13: 978-0262514675.

RUBRICFOR 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) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+LAB)	**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 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**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: VI						
ARTIFICIAL INTELLIGENCE INTEGRATED SOFTWARE ENGINEERING **Category: Professional Core Electives** **(Theory)**						
Course Code	**:**	**21AI64D1**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**8 Hrs.**
Introduction: Professional Software Development, Software Engineering Ethics, Case studies. Software Processes: Models, Process activities, Coping with Change, Process improvement. The Rational Unified Process. Computer Aided Software Engineering. Agile Software Development: Introduction to agile methods, Agile development techniques, Agile project management and scaling agile methods.	
Unit – II	**9 Hrs.**
Requirements Engineering and System Modeling: Software Requirements: Functional and Non-functional requirements. Requirements Elicitation, Specification, Validation and Change. System Modeling: Context models, Interaction models, Structural models, Behavioral models, Model driven architecture. Architectural Design: Design decisions, Architectural views, Architectural patterns and architectures.	
Unit –III	**8 Hrs.**
Development and Testing: Design and implementation: Object oriented design using UML, Design patterns, Implementation issues, Open-source development. Software Testing: Development testing, Test-driven development, Release testing, User testing. Software Evolution: Evolution processes. Legacy system evolution, Software maintenance	
Unit –IV	**10 Hrs.**
Machine Learning to Support Code Reviews in Continuous Integration Introduction, Code review in CI, Code analysis toolchain, Code extraction, Feature extraction, Model development, Making a recommendation, Visualization of the results, Full example **Using Artificial Intelligence for Auto-Generating Software for Cyber-Physical Applications** Introduction, Model-Based Methods, Learning-Based Methods, Fault Trees, Model-Based Software Engineering, Running Example, AI-Based Framework for MBSE Task, AI-based MBSE Model Construction Methods, MBSE Trade-Off Framework, Empirical Modelling Cost Comparison	
Unit –V	**10 Hrs.**
Application of Machine Learning in Software Testing Introduction, Applications of Machine Learning in software testing-Machine Learning for software fault prediction, Machine Learning for test oracles automation, Machine learning for test cases generation, Machine learning for test suite reduction, prioritization and evaluation, other tasks **Creating Test Oracles Using Machine Learning Techniques,** Introduction, Background on Test Oracles, Test Oracles Based on Machine Learning Techniques	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Summarize the activities in Software Engineering and the use of artificial Intelligence in Software Engineering
CO2	Competence in software requirements analysis and software design
CO3	Demonstrate the use of modern tools for software design by exhibiting teamwork through oral presentations and reports
CO4	Apply AI techniques to automate software engineering tasks such as testing, debugging, and code analysis
CO5	Conduct case studies to appraise the benefits of integrating AI in software engineering

Reference Books	
1	Software Engineering ,Ian Sommerville, 10th Edition, Pearson Education, 2013, ISBN: 9788131762165.
2	Artificial Intelligence Methods for Software Engineering ,Meir Kalech, Rui Abreu, Mark Last, World Scientific Publishing Co. Pte. Ltd, 1st Edition, 2021, ISBN 978-981-123-992-2, ISBN 978-981-123-993-9.
3	Software Engineering-A Practitioners Approach ,Roger.S.Pressman,7th Edition, Tata McGraw Hill, 2007, ISBN: 9780071267823
4	Fundamentals of Software Engineering ,Rajib Mall, , 3rd Edition, Prentice-hall Of India Pvt Ltd., 2012, ISBN: 9788120348981.

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)	
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: VI						
ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE **Category: Professional Core Electives** **(Theory)**						
Course Code	:	**21AI64D2**		**CIE**	:	**100 Marks**
Credits: L: T: P	:	**3:0:0**		**SEE**	:	**100 Marks**
Total Hours	:	**45L**		**SEE Duration**	:	**3 Hours**

Unit-I	**8 Hrs.**
Fundamentals of Hybrid Intelligent Systems and Agents Hybrid Intelligent Systems Are Essential for Solving Complex Problems, Hybrids Are Complex, Agent Perspectives Are Suitable for Hybrids, Motivation and Targets **Basics of Hybrid Intelligent Systems** Typical Intelligent Techniques, Advantages and Disadvantages of Typical Intelligent Techniques, Classification of Hybrid Intelligent Systems, Current Practice in Typical Hybrid Intelligent System Development,	
Unit – II	**8 Hrs.**
Basics of Agents and Multi-agent Systems Concepts of Agents and Multi-agent Systems, Agents as a Paradigm for Software Engineering, Agents and Object, Agents and Expert Systems, Approaches to Agentification, Approaches to Incorporating Intelligent Techniques into Agents, Agent-Based Hybrid Systems: State of the Art **Methodology and Framework** Traditional Methodologies, Gaia Methodology, Coordination-Oriented Methodology, Prometheus Methodology, Methodology for Analysis and Design of Agent-Based Hybrids,	
Unit –III	**10 Hrs.**
Agent-Based Hybrid Intelligent System for Financial Investment Planning Introduction to Some Models Integrated in the System, Analysis of the System, Design of the System, Architecture of the System, Implementation of the System, Case Study **Agent-Based Hybrid Intelligent System for Data Mining** Data Mining Requires Hybrid Solutions, Requirements of the Agent-Based Hybrid Systems for Data Mining, Analysis and Design of the System, Implementation of the System, Case Study	
Unit –IV	**9 Hrs.**
Introducing GPT-3 and the OpenAI API Introduction to GPT-3, Democratizing NLP: Understanding prompts, completions, and tokens, Introducing Davinci, Babbage, Curie, and Ada, Understanding GPT-3 risks. **GPT-3 Applications and Use Cases** Understanding general GPT-3 use cases, Introducing the Playground, Handling text generation and classification tasks, Understanding semantic search	
Unit –V	**10 Hrs.**
Working with the OpenAI API Understanding APIs 70, Getting familiar with HTTP, Reviewing the OpenAI API endpoints, introducing CURL and Postman, Understanding API authentication, making an authenticated request to the OpenAI API, Introducing JSON, Using the Completions endpoint, Using the Semantic Search endpoint **Calling the OpenAI API in Code** Choosing your programming language, introducing replit, Using the OpenAI API with Node.js/ JavaScript, Using the OpenAI API in Python, Using other programming languages	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the need for hybrid intelligent systems and agents for developing advanced AI applications
CO2	Use the industry frameworks for agent-based software engineering and learn the state-of-the-art in creating hybrid intelligent systems and multi-agent systems
CO3	Identify the potential applications of multi-agent systems and solve some real-world problems
CO4	Create use cases for GPT and Open AI using modern tools, and study all the required fundamentals.
CO5	Work in teams to develop solutions using GPTs useful to society and industry

Reference Books	
1	Agent-based Hybrid Intelligent Systems: An Agent-Based Framework for Complex Problem Solving, Zili Zhang, Chengqi Zhang, Springer, 2004, ISBN: 3-540-24623-1.
2	Exploring GPT-3: An unofficial first look at the general-purpose language processing API from OpenAI, Steve Tingiris, 1st Edition, Packt Publishing, 2021, ISBN: 978-1-80056-319-3
3	Multi-Agent Programming: Languages, Tools and Applications, Rafael H. Bordini, Mehdi Dastani, Jurgen Dix, Amal El Fallah Seghrouchni, 1st Edition, Springer, 2009, ISBN 978-0-387-89299-3.

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). 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)	
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: VI						
NATURE INSPIRED COMPUTING **Category: Professional Core Electives** **(Theory)**						
Course Code	**:**	**21AI64D3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Introduction: From Nature to Nature Computing , Philosophy , Three Branches: A Brief Overview, Individuals, Entities and agents - Parallelism and Distributivity Interactivity ,Adaptation- Feedback-Self-Organization-Complexity, Emergence and ,Bottom-up Vs Top-Down- Determination, Chaos and Fractals. Artificial Life Background and history of Artificial Life research, Self-organizing systems, Artificial Chemistry	
Unit – II	**09 Hrs**
Computing Inspired by Nature: Evolutionary Computing, Hill Climbing and Simulated Annealing, Darwin's Dangerous Idea, Genetics Principles, Standard Evolutionary Algorithm -Genetic Algorithms , Reproduction-Crossover, Mutation, Evolutionary Programming, Genetic Programming	
Unit –III	**09 Hrs**
Swarm Intelligence: Introduction - Ant Colonies, Ant Foraging Behavior, Ant Colony Optimization, SACO and scope of ACO algorithms, Ant Colony Algorithm (ACA), Swarm Robotics, Foraging for food, Social Adaptation of Knowledge , Particle Swarm Optimization (PSO)	
Unit –IV	**09 Hrs**
Immuno computing: Introduction- Immune System, Physiology and main components, Pattern Recognition and Binding , Immune Network Theory- Danger Theory, Evaluation Interaction- Immune Algorithms , Introduction – Bone Marrow Models , Forest's Algorithm, Artificial Immune Networks	
Unit –V	**09 Hrs**
Computing With New Natural Materials: DNA Computing: Motivation, DNA Molecule , Adleman's experiment , Test tube programming language, Universal DNA Computers , PAM Model , Splicing Systems , Lipton's Solution to SAT Problem , Scope of DNA Computing , From Classical to DNA Computing	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the strengths, weaknesses, and appropriateness of nature-inspired algorithms.
CO2	Apply nature-inspired algorithms to design and solve problems in various areas of computing, such as optimization and machine learning.
CO3	Identify the role of swarm intelligence, immuno-computing techniques and DNA Computing in solving industrial problems.
CO4	Exhibit teamwork and professional communication by developing nature-inspired computing solutions.
CO5	Use modern tools for implementing nature-inspired computing solutions.

Reference Books	
1.	Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications,Leandro Nunes de Castro, , Chapman & Hall/ CRC, Taylor and Francis Group
2.	Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies ,Floreano D. and Mattiussi C., , MIT Press, Cambridge, MA, 2008.

3.	Handbook of Nature-Inspired and Innovative Computing,Albert Y.Zomaya, Springer, 2006.
4.	Ant Colony Optimization ,Marco Dorrigo, Thomas Stutzle, PHI,2005

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
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2	Unit 1 : (Compulsory)	16
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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: VI						
SOCIAL NETWORK ANALYSIS **Category: Professional Core Electives** **(Theory)**						
Course Code	**:**	**21AI64D4**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**10 Hrs**
What is Social Network Analysis? The data used in social network analysis, Is there a network theory? An overview. **The History of Social Network Analysis** The sociogram and sociometry, Balance and group dynamics, Informal organisation and community relations, Matrices and cliques, Formal models of community and kinship, Formal methods triumphant, Getting by without the help of your friends, Entry of the social physicists	
Unit – II	**8 Hrs**
Data Collection for Social Network Analysis Asking questions, Making observations, Using documents, Boundaries in relational data, Positional and reputational approaches. **Organizing and Analyzing Network Data** Matrices and relational data, Matrix conventions, An analysis of directorship data, Direction and value in relational data, Computer programs for social network analysis.	
Unit –III	**10 Hrs**
Terminology for Network Analysis The language of network analysis, More than joining up the lines, The flow of information and resources, Density of connections, Density in ego nets, Problems in density measures, A digression on absolute density, Community structure and density **Popularity, Mediation and Exclusion** Local and overall centrality, Mediation and betweenness, Centrality boosts centrality, Centralisation and graph centres, The absolute centre of a graph, Bank centrality in corporate networks	
Unit –IV	**8 Hrs.**
Groups, Factions and Social Divisions Identifying subgraphs, The components of a network, The strength and stability of components, Cycles and circuits, The contours of components, Cliques within components, Intersecting social circles, Components and citation circles. **Structural Locations, Classes and Positions** The structural equivalence of points, Clusters and similarity, Divide and CONCOR, Divisions and equivalence, Regular equivalence in roles and functions, Corporate interlocks and participations	
Unit –V	9 Hrs
Social Change and Development Structural change and unintended consequences, Small-world networks, Modelling social change, Testing explanations. **Visualizing and Modelling** Taking space seriously, Using multi-dimensional scaling, Principal components and factors, Non-metric methods, Dimensions, Elites, communities and influence.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explore the basic concepts of social network analysis, data collection and analysis of the network data.
CO2	Apply the concepts of social network analysis to understand the growing connectivity and complexity from small groups to the World Wide Web.
CO3	Analyze various algorithm models to solve critical problems in social networks.
CO4	Demonstrate critical, innovative thinking and display competence in oral, written, and visual communication.
CO5	Work with modern tools to analyze social network data and connectivity and create solutions to benefit society and industries.

Reference Books	
1	Social Network Analysis-Sage ,John Scott - Pubns Ltd (2017) ISBN 978-1-4739-5211-9, ISBN 978-1-4739-5212-6
2	Social Networks and the Semantic Web ,Mika P, 2007, ISBN-13: 978-0-387-71000-6 e-ISBN-13: 978-0-387-71001-3
3	Online Social Media Analysis and Visualization ,Jalal Kawash (eds.) ,Springer International Publishing (2014)
4	Introduction to the second issue of Social Network Analysis and Mining journal: scientific computing for social network analysis and dynamicity, Reda Alhajj,Nasrullah Memon,2011

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)	
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: VI						
ENGINEERING APPLICATIONS OF ARTIFICIAL INTELLIGENCE **Category: Professional Core Elective – Cluster Elective** **(Theory)**						
Course Code	**:**	**21AI65E1**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs.**
Conceptual Design: Introduction, Components of smart cities, Basic requirements of sustainable smart cities: Reliability of IT, Technology lifecycle, Compatibility with existing platform, Security, Smart city design alternatives **From digital to sustainable urban systems:** Introduction, Utilization of smart city(SC) in the architecture of artificially intelligent cities: The use of AI and information computer technology for sustainable development: strengths and opportunities, Implementation of Big data in smart city practice: examples of artificially intelligent cities, From digital to sustainable: smart city(SC) strategy for urban planning: The motivation for sustainable SC strategy in the digital are, SC objectives for sustainable urban systems, The use of SC in urban planning process: pros and cons	
Unit – II	**09 Hrs.**
Industry 4.0 for smart cities: Introduction, Industry 4.0, Smart City, Dimensions of smart city, Enabling technologies: cloud/edge computing, AI, IoT, Industry 4.0 and smart cities, applications of AI and industry 4.0 in smart cities, Discussion: Transportation, Healthcare, Smart Home, Agriculture, Electric supply, Waste management **Waste Management for smart cities:** Current state of WM, Waste categorization and WM problems, WM solutions for smart cities, AI solutions, smart WM information systems for SC, intelligent technology-based solutions: Block chain, Cloud and fog, Drone technology, IoT based including GPS	
Unit –III	**09 Hrs.**
Sustainable financing of smart cities: Introduction, distinctive features of smart city finance, financial sustainability of smart cities, financing methods for smart cities: traditional methods, innovative financing methods, application of AI tools in financing smart cities: AI inspire-investment decision-making process, managing regulations, financial benefits of using acquired data: data monetizing, utilizing data to determine financial and non-financial returns, impact of AI on crowdfunding, merging block chain , AI and IoT	
Unit –IV	**09 Hrs.**
Current healthcare, big data and machine learning: Current healthcare practice, value-based treatment and healthcare services, increasing data volumes in healthcare, analytics of healthcare data **The rise of AI in healthcare applications:** The new age of healthcare, precision medicine, AI and medical visualization, intelligent personal health records, robotics and AI-powered devices, ambient assisted living **Cancer diagnostics and treatment decisions using AI:** AI, ML and DL in cancer, AI to determine cancer susceptibility, AI for enhanced cancer diagnosis and staging, AI to predict cancer treatment response, AI to predict cancer recurrence and survival, AI for personalized cancer pharmacotherapy	
Unit –V	**09 Hrs.**
AI for advanced driver assistance systems: Automatic Parking, Traffic Sign Recognition, Driver Monitoring System **AI for autonomous driving**: Perception, Planning, Motion Control **AI for in-vehicle infotainment systems:** Gesture Control, Voice Assistant, User Action Prediction **AI for research & development:** Automated Rules Generation, Virtual Testing Platform, Synthetic Scenario Generation **AI for services:** Predictive Diagnostics, Predictive Maintenance, Driver Behavior Analysis	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the need for Artificial Intelligence in some of the engineering domains.
CO2	Identify and analyze some AI use cases in engineering domains like smart cities, healthcare, automobiles, etc.
CO3	Apply AI and develop or propose solutions for some engineering applications using AI tools.
CO4	Investigate some novel applications of AI in engineering domains applicable to industry and society.
CO5	Appraise the knowledge and potential of AI, work in teams, and communicate their ideas effectively.

Text Book/Reference Books	
1	Artificial Intelligence perspective for Smart Cities, Vahap Tecim and Sezer Bozkus Kahyaoglu, CRC Press, 1st Edition, 2023, ISBN: 978-1-032-13619-
2	Artificial Intelligence in Healthcare, Adam Bohr and Kaveh Memarzadeh, Elsevier Academic Press, 2020, ISBN: 978-0-12-818438-7
3	AI for Cars, Josep Aulinas and Hanky Sjafrie, Chapman and Hall/CRC, 1st Edition, 2021

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**
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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**
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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: VI						
QUANTUM COMPUTING **Category: Professional Core Elective – Cluster Elective** **(Theory)**						
Course Code	**:**	**21AI65E2**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs.**
Quantum Building Blocks: Quantum mechanics of Photon Polarization, Single Quantum bits, Single Qubit Measurement, A Quantum key Distribution Protocol, State Space of a Single-Qubit System, Direct Sums and Tensor Products of Vector Spaces, State Space of an n-Qubit System, Entangled States, Multi-Qubit Measurement, QKD using Entangled states	
Unit – II	**09 Hrs.**
Multiple-Qubit States Measurements: Dirac Bra/Ket Notation for Linear Transformation, Projection Operators for Measurement, Hermitian Operator Formalism for Measurement, EPR Paradox and Bell's Theorem.	
Unit –III	**09 Hrs.**
Quantum State Transformations: Unitary transformations, No-Cloning Principle, Some Simple Quantum Gates, Pauli transformations, Hadamard Transformations, Multiple-Qubit Transformations, Controlled-NOT and other singly controlled gates, Applications of Simple Gates, Dense coding, Quantum teleportation	
Unit –IV	**09 Hrs.**
Introduction To Quantum Algorithms: Computing with Superpositions, Walsh-Hadamard transformation, Quantum Parallelism, Notions of Complexity, Query Complexity, Communication Complexity, Simple Quantum Algorithm- Deutsch's Problem	
Unit –V	**09 Hrs.**
Simple Quantum Algorithms: Deutsch-Jozsa Problem, Bernstein-Vazirani Problem, Simon's Problem**,** Machine Models and Complexity Classes, Shor's factoring Algorithm, Example illustrating Shor's Algorithm	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the various essentials of quantum computation, Qubits, and Quantum operators.
CO2	Analyze the working of quantum transformations and quantum gates.
CO3	Describe the principle of working of some of the quantum algorithms and conduct simulations using open-source quantum simulators.
CO4	Investigate the applications of quantum computing algorithms and quantum cryptography in real-world applications.
CO5	Appraise the knowledge and potential in quantum computing to build a successful career, work in teams, and communicate their ideas effectively.

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

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**
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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**
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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
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7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
COMPUTER VISION **Category: Professional Core Elective – Cluster Elective** **(Cluster Elective)**						
Course Code	**:**	**21CS65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Geometric Camera Models: **Image Formation:** Pinhole Perspective, Weak perspective, Cameras with lenses; **Geometric Camera Calibration:** Linear approach to camera calibration, Non- Linear approach to camera calibration; **Light and Shading:Modeling Pixel brightness:** Reflection at surfaces, Sources and their effects, Lambertineaand Spectacular model, Area sources; **Inferences from shading*:*** Radiometric calibration and high dynamic range images, The Shape of Specularities , Inferring Lightness and Illumination, Photometric Stereo: Shape from Multiple Shaded Images.	
Unit – II	**09 Hrs**
Early vision: **Linear Filters:**Linear Filters and Convolution; Shift Invariant Linear Systems: Discrete Convolution, Continuous Convolution, Edge Effects in Discrete Convolution; Spatial Frequency and Fourier Transforms: Fourier Transforms; Sampling and Aliasing, Filters as Templates; **Stereopsis:** Binocular Camera Geometry and the Epipolar constraint- Epipolar geometry, The essential matrix , The fundamental matrix ; Binocular reconstruction : Image rectification.	
Unit –III	**09 Hrs**
Mid level Vision: Segmentation by clustering, Human Vision: Grouping and Gestalt; Important applications; Image Segmentations by Clustering pixels; Segmentation, Clustering, and Graphs. **Grouping and Model Fitting:** The Hough transform, Fitting lines and planes; Fitting Curved Structure; Robustness; Fitting using Probabilistic models; Motion Segmentation by Parameter estimation. **Tracking:** Simple Tracking strategies; Tracking using Matching; Tracking Linear dynamics models with Kalman filters.	
Unit –IV	**09 Hrs**
High level Vision: Registration; Model based Vision: Registering Rigid Objects; Registering deformable objects. **Classifying images:** Building good Image features; Classifying Images of Single Objects; Image Classification in practice.	
Unit –V	**09 Hrs**
Detecting Objects in Images: Sliding Window method; Detecting Deformable Objects; The State of the Art of Detection **Object recognition:** Basics of Object Recognition: Object Recognition System, Current Strategies, Categorization, Selection; Feature questions; Geometrical questions; Semantic questions.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore and acquire knowledge on fundamentals of Computer Vision concepts.
CO2:	Analyze and interpret the inherent difficulties encountered in Computer Vision.
CO3:	Apply Computer Vision techniques to solve problems in the visible world around us.
CO4:	Investigate and draw inferences by processing Image in real time applications.

Reference Books	
1	Computer Vision: A Modern Approach, David Forsyth and Jean Ponce, 2nd edition, 2015, Pearson Education India, ISBN-10: 9332550115, ISBN-13 : 978-9332550117
2	Computer Vision: Algorithms and Applications, Richard Szeliski, Springer Verlag, 2013 Edition, ISBN-13: 978-1848829343, ebook :http://szeliski.org/Book/
3	Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, 4th Edition; 2018, Pearson Education, ISBN-10: 9353062985, ISBN-13: 978-9353062989
4	Introductory Computer Vision, Imaging Techniques and Solutions, Adrian Low , 2nd Edition, 2010, BS Publications, ISBN-13 9788178001977

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. **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 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: VI						
ENTERPRISE ARCHITECTURE **Category: Professional Core Elective – Cluster Elective** **(Cluster Elective)**						
Course Code	**:**	**21CS65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**10 Hrs**
Introduction to Enterprise Architecture: Evolution of Enterprise Architecture, Popular Enterprise Architecture Frameworks, Primary Domains of Enterprise Architecture, Value Benefits of Enterprise Architecture, Emerging Trends in Enterprise Architecture, Roles in Enterprise Architecture. **TOGAF Standard:** Development of EA with TOGAF Standard, Taxonomy and Core Concepts, Enterprise Architecture Development Method, Architecture Content, Enterprise Architecture Capability and Governance.	
Unit – II	**8 Hrs**
EA Modelling: Language and Tools, Importance of Modelling in Enterprise Architecture, Enterprise Architecture Modelling Language – ArchiMate, Enterprise Architecture Tools	
Unit –III	**8 Hrs**
Reference Architectures: Overview of Reference Architectures, Leading Reference Architectures (RA), Re-Architecting the IT Functions for Managing Digital Lifecycle, Introduction to Digital Product, Key Taxonomies.	
Unit –IV	**10 Hrs**
IT Value Streams in Managing Digital, IT4IT Level 1 Reference Architecture, Brief on Digital Product Backbone Object, Service Offer Backbone Data Objects. **Leveraging Enterprise Architecture for Strategic Initiatives**: Supply Chain Transformation, Merger, Acquisition & Divestiture Transition, Government to Citizen Service Transformation, IT Portfolio Rationalization, Architecture for Digital Technologies	
Unit –V	**9 Hrs**
Realizing Values through Enterprise Architecture: Key Performance Indicators, Metrices to Measure Enterprise Architecture Values **Managing Enterprise Architecture Operations:** Setting up Enterprise Architecture Office, Sustaining Enterprise Architecture Office, Enterprise Architecture Program Management, Common EA Pitfalls to Avoid	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Acquire basic knowledge and skills to elaborate EA models, apply EA approach & methods and use EA in management decision and communication situations.
CO2:	Leverage Enterprise Architecture for various strategic initiatives like supply chain transformation, IT portfolio rationalization, and divestiture transitions
CO3:	Apply metrics, indicators, risk evaluations related to EA model building blocks and objects.
CO4:	Understand and clearly allocate responsibilities within an organization using EA models.
CO5:	Express and supplement their own analysis and conclusions using EA terminology, business & IT architecture models as a platform of common understanding.

Reference Books	
1	An Introduction to Holistic Enterprise Architecture, Scott A. Bernard, 4th Edition, 2020, Authorhouse, ISBN: 978-1728358055
2	Enterprise DevOps for Architects: Leverage AIOps and DevSecOps for secure digital transformation, JeroenMulde, 2021, Packt Publishing, ISBN:978-1801812153
3	Mastering ArchiMate Edition 3.1: A Serious Introduction to the ArchiMate® Enterprise Architecture Modeling Language, GerbenWierda, 2021, R&A, ISBN: 978-9083143415
4	TOGAF standards and White Papers published by The Open Group.

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. **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 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: VI						
HUMAN COMPUTER INTERACTION **Category: Professional Core Elective – Cluster Elective** **(Cluster Elective)**						
Course Code	**:**	**21IS65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
Usability of Interactive Systems: Introduction, Usability goals and Measures, Usability Motivations, Universal Usability, Goals for Our Profession; **Guidelines, Principles, and Theories**: Introduction, Guidelines, Principles, and Theories.	
Unit – II	**08 Hrs**
Managing Design Processes: Introduction, Organizational Design to Support Usability, The Four Pillars of Design, Development Methodologies, Ethnographic Observation, Participatory Design, Scenario Development, Social Impact Statement for Early Design Review, Legal Issues. **Evaluating Interface Designs**: Introduction, Expert Reviews, and Usability Testing and Laboratories, Survey Instruments, Acceptance Tests, Evaluation During Active Use Controlled Psychologically Oriented Experiments.	
Unit –III	**09 Hrs**
Direct Manipulation and Virtual Environment: Introduction Examples of Direct Manipulation, Discussion of Direct Manipulation, 3D Interfaces Teleoperation, Virtual and Augmented Reality. **Menu Selection, Form Fill-in, and Dialog Boxes:** Introduction, Task-Related Menu Organization, Single Menus, Combinations of Multiple Menus, Content Organization Fast Movement through Menus, Data Entry with Menus: Form Fill-in, Dialog Boxes and Alternatives, Audio Menus and Menus for Small Displays.	
Unit –IV	**08 Hrs**
Collaboration and Social Media Participation: Introduction, Goals of Collaboration and Participation, Asynchronous Distributed Interfaces: Different Place, Different Time Synchronous Distributed Interfaces: Different Place, Same Time, Face-to-Face Interfaces: Same Place, Same Time. **Quality of Service:** Introduction, Models of Response Time Impacts Expectations and Attitudes, User Productivity, Variability in Response Time, Frustrating Experiences.	
Unit –V	**09 Hrs**
Balancing Function and Fashion: Introduction, Error Messages, Non anthropomorphic Design, Display Design, Web Page Design, Window Design, Color. **User Documentation and Online Help:** Introduction, Online versus Paper, Documentation, Reading from Paper versus from Displays, Shaping the Content of the Documentation, Accessing the Documentation, Online Tutorials and Animated Demonstrations, Online Communities for User Assistance, The Development Process. **Information Search:** Introduction, Searching in Textual Documents and Database Querying, Multimedia Document Searches, Advanced Filtering and Search Interface.	

Reference Books

1.	Designing the User Interface: Techniques for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, Pearson Publications, 6th Edition, 2016, ISBN: 9780123822291.
2.	The essential guide to user interface, Wilbert O Galitz, Wiley, 3rd Edition,2007, ISBN: 978-0-471-27139-0.
3.	Human – Computer Interaction, Alan Dix, Janet Fincay, GreGoryd, Abowd, Russell Bealg, Pearson 3rd Edition,2004, ISBN 0-13-046109-1.
4.	Interaction Design, Prece, Rogers, Sharps, Wiley, 3rd Edition,2011, ISBN: 978-1-119-02075-2.

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, 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. 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 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: VI						
CLOUD COMPUTING **Category: Professional Core Elective – Cluster Elective** **(Cluster Elective)**						
Course Code	**:**	**21IS65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
Introduction to Cloud Computing: Defining cloud computing, types of cloud, Characteristics of cloud computing, benefits of cloud computing, Disadvantages of cloud computing. **Services & Applications:** Defining infrastructure as a service (Iaas); Defining Software as a service (SaaS); Defining Platform as aservice (PaaS); Defining identity management as a service (IDaaS); Defining Communications as a Service(CaaS).	
Unit – II	**08 Hrs**
Using Google Web Services: Exploring Google Applications, Surveying the Google Application Portfolio, Exploring the Google Toolkit, Working with the Google App Engine **Using Amazon Web Services:** Understanding Amazon Web Services, Amazon Web Services Components and Servies, Working with EC2, Working with Amazon Storage Systems, Understanding Amazon Database Services **Using Microsoft Cloud Services:** Exploring Microsoft Cloud Services, Defining the Windows Azure Platform, Using Windows Live	
Unit –III	**08 Hrs**
Hardware and Infrastructure: Clients, Security, Network, Services **Accessing the Cloud**: Platforms: Web Applications, Web APIs, Web Browsers **Cloud Storage**: Overview, Cloud Storage Providers **Standards**: Application, Client, Infrastructure, Service	
Unit –IV	**08 Hrs**
SaaS: Overview, Driving Forces, Company Offerings, Industries **Software plus Services**: Overview, Mobile Device Integration, Providers, Microsoft Online **Developing Applications**: Google, Microsoft, Intuit QuickBase, Cast Iron Cloud, Bungee Connect, Development, Application Management	
Unit –V	**08 Hrs**
Local Clouds and Thin Clients: Virtualization in Organization, Server Solutions, Thin Clients **Migrating to the Cloud**: Cloud Services for Individuals, Cloud Services Aimed at the Mid-market, Enterprise Class Cloud Offerings, Migration	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the basics of cloud computing models and virtualization.
CO2	Evaluate the issues related to the development of cloud applications.
CO3	Apply the concepts to design cloud based simple applications.
CO4	Analyse real world case studies of existing cloud based software solutions.

Reference Books	
1	Cloud computing bible, Barrie Sosinsky, CRC Press, 2010, ISBN: 978-0-470-90356-8.
2.	Cloud Computing, A practical Approach, Toby Velte, Anthony Velte, Robert Elsenpeter, 2011, Wiley India, ISBN: 0071626948
3.	Cloud Application Architectures, George Reese, Wiley India 2011, ISBN: 978-0596156367.
4.	Cloud Computing-Web Based applications that change the way you work and collaborate online, Michael Miller, Pearson Education, 2009, ISBN: 9780789738035.

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, 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. 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 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: VI						
INDUSTRIAL SAFETY AND RISK MANAGEMENT **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
Introduction Safety: Introduction to industrial safety engineering, major industrial accidents, safety and health issues, key concepts and terminologies, Hazard theory, Hazard triangle, Hazard actuation, Actuation transition, Causal factors, Hazard recognition.	
Unit – II	**08 Hrs**
Risk assessment and control: Individual and societal risks, Risk assessment, Risk perception, Acceptable risk, ALARP, Prevention through design. **Hazard Identification Methods:** Preliminary Hazard List (PHL): Overview, methodology, worksheets, case study. Preliminary Hazard Analysis (PHA), Fault tree and Event tree analyses.	
Unit –III	**08 Hrs**
Hazard analysis: Hazard and Operability Study (HAZOP): Definition, Process parameters, Guide words, HAZOP matrix, Procedure, Example. Failure Modes and Effects Analysis (FMEA): Introduction, system breakdown concept, methodology, example.	
Unit –IV	**08 Hrs**
Application of Hazard Identification Techniques: Case of pressure tank, heat exchanger, system breakdown structure, Accident paths, HAZOP application, risk adjusted discounted rate method, probability distribution, Hiller's model	
Unit –V	**08 Hrs**
Safety in process industries and case studies: Personnel Protection Equipment (PPE): Safety glasses, face shields, welding helmets, absorptive lenses, hard hats, types of hand PPE, types of foot PPE, types of body PPE. Bhopal gas tragedy, Chernobyl nuclear disaster, Chemical plant explosion and fire.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Recall risk assessment techniques used in process industry
CO2	Interpret the various risk assessment tools.
CO3	Use hazard identification tools for safety management.
CO4	Analyze tools and safety procedures for protection in process industries.

Reference Books	
2.	Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina,Lulu publication, ISBN:1291187235.
2.	Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X.
3.	Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition, 2003,The University of alberta press,Canada, ISBN: 0888643942.
4.	ndustrial Safety, Health and Environment Management Systems, R K Jain, Sunil S Rao, 4th Edition, 2005, Khanna Publishers, New Delhi, ISBN: 8174092102.

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: VI						
RENEWABLE ENERGY SYSTEMS **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F2**		**CIE**	**:**	**100Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**08 Hrs**
Introduction: Energy systems model causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. **Basics of Solar Energy:** Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Application. Block diagram of solar energy conversion.	
Unit – II	**08 Hrs**
Solar PV Systems: Basic Principle of SPV conversion – Types of PV Systems(Standalone, Grid connected, Hybrid system)- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Array design (different methodologies),peak-power operation, system components.Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications..	
Unit –III	**08 Hrs**
Wind Power Systems: **Wind speed and energy:** Introduction, history of wind energy, scenario- world and India. Basic principle of Wind energy conversion system (WECS), Classifications of WECS, part of a WECS. Derivation of power in the wind, electrical power output and capacity of WECS, wind site selection consideration, advantages and disadvantages of WECS. Maximum energy capture, maximum power operation, , environmental aspects.	
Unit –IV	**08 Hrs**
Geothermal and ocean energy systems: Geothermal well drilling, advantages and disadvantages, Comparison of flashed steam and total flow concept (T-S diagram). Associated Problems, environmental Effects. **Energy from ocean:** OTEC power generation, OPEN and CLOSED cycle OTEC. Estimate of Energy and power in simple single basin tidal and double basin tidal system. Issues Faced in Exploiting Tidal Energy	
Unit –V	**08 Hrs**
Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production through block diagram, Use of Hydrogen Energy, Merits and Demerits, Problems Associated with Hydrogen Energy. **Biomass Energy:** Introduction-Biomass resources –Energy from Biomass: conversion processes-Biomass Cogeneration-Environmental Benefits. Biomass products – ethanol, biodiesel, biogas Electricity and heat production by biomass.	

Course Outcomes: After completing the course, the students will be able to: -	
CO 1	Understand the working principle and operation of various renewable energy sources and systems.
CO 2	Analyze the performance and characteristics of renewable energy sources and systems.
CO 3	Evaluate the parameters of wind and solar energy systems.
CO 4	Design and demonstrate the applications of renewable energy sources in a typical systems.

Reference Books	
1.	Non conventional energy sources, by G.D Rai, Khanna publishes, 19th Edition, 2017, ISBN: 978-81-7409-073-8
2.	Solar photo voltaic Technology and systems, by Chetan Singh Solanki, 3rd Edition, PHI, Learning private limited New Delhi, 2013, ISBN: 978-81-203-4711-3.
3.	Wind and solar power system design, Analysis and operation, Mukund R. Patel, 2nd Edition. CRC Group, Taylor and Francis group, New Delhi, ISBN 978-0-8493-1570-1.
4.	Renewable energy: Technology, Economics and Environment, Martin Kaltschmitt, Wolfgang Streicher Andreas Wiese, Springer Publication, 2007, ISBN 978-3-540-70947- 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). 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)	
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: VI						
SYSTEMS ENGINEERING **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**06 Hrs**
System Engineering and the World of Modem System: What is System Engineering?, Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems.	
Unit – II	**10 Hrs**
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. **Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems.	
Unit –III	**10 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	
Unit –IV	**10 Hrs**
Engineering Design: Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	
Unit –V	**09 Hrs**
Production: Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems. **Operations and support**: Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems.	

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

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

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
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
MECHATRONICS **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6E4**		**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**
Overview of Mechatronic Systems Traditional and mechatronic design, automatic washing machine, automatic door, dishwasher, compact disc drive copy machine, camera and temperature control. Principle and working of hall sensor, displacement sensor, absolute and incremental encoders, photoelectric sensors, inductive and capacitive proximity sensors, Relays and solenoids, Brushless DC, AC and servo motors, pulse width modulation by basic transistor circuit, H bridge circuit, Stepper motor: variable reluctance and permanent magnet, stepper motor control circuits, selection of motors.	
Unit – II	**10 Hrs**
Signal Conditioning Operational Amplifiers - circuit diagrams and derivation - Numerical, filtering, multiplexers, 4:1 MUX, time division multiplexing -seven segment display, data acquisition, Analog and digital signals, analog to digital converters. Introduction to Digital signal processing – difference equation (Numericals). **Programmable logic controllers** Components, principle of operation, modifying the operation, basic PLC instructions, and concepts of ladder diagram, latching, timer instructions, counter instructions.	
Unit –III	**10 Hrs**
Ladder Diagram for PLCs Examples with ladder logic programs, simple programs using Boolean logic, word level logic instructions. Relay to ladder conversion examples., **Industrial applications of PLCs** Central heating system, valve sequencing, traffic light control in one direction, water level control, overhead garage door, sequential process, continuous filling operation, Fluid pumping with timers, parking garage counter, can counting in assembly line.	
Unit –IV	**08 Hrs**
Microcontrollers Components of a full featured microcontroller, Memory, I/O Ports, Bus, Read & Write Cycle, Architecture of Intel 8051 microcontroller, Pin diagram, simple instructions for a microcontroller. – Data transfer, arithmetic functions, logical operations, Jump and branching operation. **Digital circuits** Digital representations, Combinational logic - Case studies: BCD to 7 segment decoder, calendar subsystem in a smartwatch., timing diagrams, Karnough maps – 3 variable and 4 variable, design of logic networks, flip-flops, Counters.	

Unit –V	08 Hrs
Dynamic Responses of Systems Closed loop system, Terminology, transfer functions, step response of first order and second order systems, performance measures for first and second order systems, - Numerical **Mechanical Actuation Systems** Four bar chain, slider crank mechanism, Cams and followers, gear trains - Numerical	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Select appropriate sensors and transducers and devise an instrumentation system for collecting information about processes
CO2	Apply the electrical and logic concepts and inspect the functioning of mechatronic systems.
CO3	Evaluate a control system for effective functioning of Mechatronics systems using digital electronics, microprocessors, microcontrollers and programmable logic controllers
CO4	Develop conceptual design for Mechatronics products based on potential customer requirements

Reference Books	
1.	Nitaigour Premchand, 'Mechatronics-Principles, Concepts & Applications', TMH 1st Edition, 2009, ISBN: 9780070483743
2.	Bolton W., 'Mechatronics-Electronic Control System in Mechanical and Electrical Engineering', Pearson Education, 4th Edition, 2012; ISBN:9788131732533
3.	Tilak Thakur 'Mechatronics', Oxford University Press, I Edition, 2016, ISBN: 9780199459329
4.	Petruzella, Frank D, Programmable logic controllers, McGraw-Hill, 4th Edition, 2013, ISBN-13: 978-0-07-351088-0

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: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI						
MATHEMATICAL MODELLING **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6E5**		**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**
Continuous Models Using Ordinary Differential Equations: Basic concepts, real world problems (Science and Engineering), approximation of the problem, steps involved in modelling, formation of various continuous models.	
Unit – II	**09 Hrs**
Mathematically Modelling Discrete Processes: Difference equations - first and second order, introduction to difference equations, introduction to discrete models-simple examples, mathematical modelling through difference equations in economics, finance, population dynamics, genetics and other real-world problems.	
Unit –III	**09 Hrs**
Markov modelling: Mathematical foundations of Markov chain, applications of Markov modelling.	
Unit –IV	**09 Hrs**
Modelling through graphs: Graph theory concepts, modelling situations through different types of graphs.	
Unit –V	**09 Hrs**
Variational Problem and Dynamic Programming: Optimization principles and techniques, mathematical models of variational problem and dynamic programming and applications.	

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

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

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: VI						
INDUSTRY 4.0 - SMART MANUFACTURING FOR THE FUTURE **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6E6**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42 Hrs**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**07 Hrs**
Introduction: The Various Industrial Revolutions, Need – Reason for Adopting Industry 4.0, Definition, Goals and Design Principles – Interoperability, Virtualization, Decentralization, Real-time Capability, Service Orientation, Modularity. Individualization, Volatility, Energy and resource efficiency. Road to Industry 4.0 - Internet of Things (IoT), Architecture of IoT, Technologies for IoT & Industrial Internet of Things (IIoT), Internet of Services, Standardization, Cyber-Physical Systems, Smart Manufacturing, Network via Ethernet/ Wi-Fi for high-speed data transmission, Mobile technologies	
Unit – II	**10 Hrs**
Opportunities and Challenges Lack of resources, Availability of skilled workers, Broadband infrastructure, Policies, Future of Works and Skills in the Industry 4.0 Era, Disruption as manufacturing's greatest modern challenge **Robotics in Industry 4.0** Robotic Automation and Collaborative Robots, Human-Machine Interaction **Big Data** Evolution**,** Essential of Big Data in Industry 4.0, Big Data Merits, Data transparency, Business Intelligence, Production planning, Quality, Acquisition of Automation Data, Digital Traceability, Radio-Frequency Identification (RFID), GPS, Data transformation, Big Data Characteristics, Data as a new resource for organizations, Data driven applications, Harnessing and sharing knowledge in organizations, Data analytics - Descriptive Analytics, Diagnostic analytics, Predictive Analytics, Prescriptive analytics	
Unit –III	**10 Hrs**
Cloud Computing Fundamentals, Cloud/Edge Computing and Industry 4.0, The IT/OT convergence, Cyber Security **Horizontal and Vertical integration** End-to-end engineering of the overall value chain, Digital integration platforms, Role of machine sensors, Sensing classification according to measuring variables, Machine-to-Machine communication **Artificial Intelligence/Machine Learning in Industry 4.0** Fundamentals, Case Studies, Technology paradigms in production logistics - Intelligent conveyor system, Intelligent commissioning system, Intelligent production machine, Intelligent load carrier, Application-specific demand on Intelligent Objects (user-oriented functions), Technological realization of Intelligent Objects (product-oriented functions)	

Unit –IV	08 Hrs
Augmented Worker Augmented and Virtual Reality, softwares, Industrial Applications – Maintenance, Assembly, Collaborative operations, Training **Digital-to-Physical** Additive Manufacturing technologies, Advantages, impact on environment, Applications – Automotive, Aerospace, Electronics and Medical	
Unit –V	**07 Hrs**
Digital twin, Virtual factory, Total Productive Maintenance, Industry 4.0 case studies, Understanding I 4.0 in MSMEs, What's Next: Industry 5.0/Society 5.0	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Identify the basic components of Industry 4.0
CO2	Analyse the role of Big data for modern manufacturing
CO3	Create AR/VR models for industrial scenario
CO4	Create simple Additive manufactured parts

Reference Books	
2.	Industry 4.0: Managing the Digital Transformation, Alp Ustundag, Emre Cevikcan, 2017, Springer, ISBN: 978-3-319-57869-9, ISBN: 978-3-319-57870-5
2.	The Concept Industry 4.0 - An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, 2017, Springer Gabler, ISBN 978-3-658-16501-7 ISBN 978-3-658-16502-4
3.	Industry 4.0 - The Industrial Internet of Things, Alasdair Gilchrist, 2016, APRESS, ISBN-13 978-1-4842-2046-7 ISBN-13: 978-1-4842-2047-4
4.	Digitizing the Industry – Internet of Things connecting the Physical, Digital and Virtual Worlds, Ovidiu Vermesan, 2016, River Publishers, ISBN 978-87-93379-81-7 ISBN 978-87-93379-82-4

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). 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: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI						
INDUSTRIAL PSYCHOLOGY FOR ENGINEERS **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F7**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**08 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology- Clinical, Industrial). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit – II	**08 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit –III	**10 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio-Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment.	
Unit –IV	**10 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.	
Unit –V	**09 Hrs**
Application of Psychology in Working Environment: The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. **Psychological Stress**: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress.Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control. Type A and Type B.**Psychological Counseling** - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors 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 intelligence, aptitude, 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.
CO5	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.

Reference Books	
1.	Understanding Psychology Feldman R. S, IV Edition, (1996) McGraw Hill India
2.	Psychology Robert A. Baron, III edition (1995) Prentice Hall India.
3.	Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3
4.	Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5
5	Psychology-themes and variations , Wayne Weiten, IV edition, Brooks / Cole Publishing Co.

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
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ELEMENTS OF FINANCIAL MANAGEMENT **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F8**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**06 Hrs**
Financial Management-An overview: Financial Decisions in a firm, Goals of a firm, Fundamental principle of finance, Organization of finance function and its relation to other functions, Regulatory framework. **The financial System:** Functions, Assets, Markets, Market returns, Intermediaries, regulatory framework, Growth and trends in Indian financial system. **Financial statements, Taxes and cash flow:** Balance sheet, statement of profit and loss, items in annual report, manipulation of bottom line, Profits vs Cash flows, Taxes. **(Conceptual treatment only)**	
Unit – II	**10 Hrs**
Time Value of Money: Future value of a single amount, future value of an annuity, present value of a single amount, present value of an annuity. **Valuation of securities:** Basic valuation model, bond valuation, equity valuation-dividend capitalization approach and other approaches. **Risk and Return:** Risk and Return of single assets and portfolios, measurement of market risk, relationship between risk and return, implications **(Conceptual and Numerical treatment)**	
Unit –III	**10 Hrs**
Techniques of Capital Budgeting: Capital budgeting process, project classification, investment criteria, Net present value, Benefit-Cost ratio, Internal Rate of return, Payback period, Accounting rate of return. **Cost of Capital:** Preliminaries Cost of debt and preference, cost of retained earnings, cost of external equity, determining the proportions, weighted average cost of capital, weighted marginal cost of capital schedule. **Capital structure and cost of capital:** Assumptions and concepts, net income approach, net operating income approach, traditional position, Modigliani and Miller Position, Taxation and Capital structure, Other imperfections and Capital structure **(Conceptual and Numerical treatment)**	
Unit –IV	**10 Hrs**
Long term finance: Sources- Equity capital, Internal accruals, preference capital, term loans, debentures. Raising long term finance- Venture capital, Initial Public Offer, Follow on Public Offer, Rights Issue, Private Placement, Term Loans, Investment Banking **Securities Market:** Primary market vs Secondary market, Trading and Settlements, Stock market quotations and Indices, Govt. securities market, Corporate debt market. **Working Capital – Policy and Financing:** Factors influencing working capital requirements, Current assets financing policy, operating cycle and cash cycle. Accruals, trade credit, banks, public deposits, inter-corporate deposits, short term loans, right debentures, commercial paper, Factoring **(Conceptual treatment only)**	
Unit –V	**09 Hrs**
Contemporary topics in Finance: Reasons and Mechanics of a merger, Takeovers, Divestures, Demergers, World monetary system, Foreign exchange markets, raising foreign currency finance, International capital budgeting, Options market, Futures market, Warrants, Venture capital financing framework, Indian venture capital scenario. (Conceptual treatment only)	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the features of financial system and basic principles of financial management.
CO2	Describe the processes and techniques of capital budgeting and theories of capital structure.
CO3	Demonstrate an understanding of various sources of long term and working capital financing by organizations.
CO4	Analyze the trends in global financial scenarios.

Reference Books:	
1.	Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill
2.	Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5
3.	Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018,
4.	McGraw Hill Education(India) Pvt. Ltd, ISBN: 9353162181 , 9789353162184

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
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
UNIVERSAL HUMAN VALUES – II **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F9**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**10 Hrs**
Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution. The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution are the activities of the Self, Self is central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.	
Unit – II	**10 Hrs**
Right Understanding (Knowing)- Knower, Known & the Process. The domain of right understanding starts from understanding the human being (the knower, the experiencer and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	
Unit –III	**08 Hrs**
Understanding Existence (including Nature). A comprehensive understanding (knowledge) about the existence, which certainly includes the Nature. The need and the process of inner evolution (through self-exploration, self-awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	
Unit –IV	**08 Hrs**
Understanding Human Being. Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body, the activities and potentialities of the self, Reasons for harmony/contradiction in the self.	
Unit –V	**08 Hrs**
Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living. Understanding Human Conduct, Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence.	

Course Outcomes: After completion of the course the students will be able to	
CO1	Understand the basic human aspiration with program of its fulfilment and meaning of resolution in the complete expanse of human living.
CO2	Understand human being in depth and see how self is central to human being
CO3	Understand existence in depth and see how coexistence is central to existence
CO4	Understand human conduct and the holistic way of living leading to human tradition

Reference Books	
1	A foundation course in human values and professional ethics, R. R. Gaur, R Asthana, G P Bagaria, 2nd revised Edition, excel books, New Delhi – 2019, ISN 978-93-87034-47-1
2	Avartansheel Arthshastra, A Nagraj, Divya Path Sansthan, Amarkantak, India, ISBN 978-8-174-46781-2
3	Economy of Performance- a quest for social order based on non – violence, J C Kumarappa, 2010, Sarva-Seva-Sangh-Prakashan, Varanasi, India
4	Energy and Equity, Ivan Illich, 1974, The Trinity Press, Worcester & Harper Collins, USA, ISBN, 0060803274, 9780060803278

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)	
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: VI						
HUMAN MACHINE INTERACTION **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42Hrs**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**10 Hrs**
Foundations of HMI: The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving. The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms. Introduction to HMI and domains- Automotive, Industrial, CE, Medical, ECUs within car and their functionalities. Interaction between ECUs. Communication protocols for ECUs(CAN, LIN, Most, FlexRay, Ethernet etc	
Unit – II	**10 Hrs**
Automotive Human-Machine Interfaces: Automotive infotainment system - Evolution road map, Feature sets, System architecture, Trends, Human factors and ergonomics in automotive design, Automotive User Experience (UX) Design Principles, In-Vehicle Information Systems (IVIS), Driver-Assistance Systems (DAS) Interfaces, HMI design for adaptive cruise control, Voice and Gesture Recognition in Automotive HMIs, Touchscreen Interfaces and Controls, Usability Testing and Evaluation in Automotive HMIs, Safety Considerations and Regulations in Automotive HMIs, Emerging Technologies in Automotive HMIs, Human-Machine Interfaces for Autonomous Vehicles	
Unit –III	**08 Hrs**
UX and Guidelines: Introduction to UX design - stages, theory, Design thinking, UX Study, Interaction concepts, Graphic design tools - Adobe Photoshop, Adobe XD, Blender, GIMP, Asset Design - Overview , Guidelines and norms, 2D/3D rendering, OpenGL, OSG.	
Unit –IV	**08 Hrs**
HMI User Interface: User-centered HMI development process, Basics of Web-Server. Web-based HMI: Basics of TwinCAT and HTML, CSS, JavaScript. HMI on Mobile: Four Principles of Mobile UI Design, Benefits of Mobile HMIs, Mobile HMI Development Suites.	
Unit –V	**08 Hrs**
HMI Control Systems: Introduction to Voice-Based HMI, Gesture-Based HMI, Sensor-Based UI controls. Haptics in Automotive HMI: Kinesthetic Feedback Systems, Tactile Feedback Systems, Haptics in Multimodal HMI, Automotive Use-Cases **HMI Testing:** Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool -Graphics Test Systems (GTS), **UI analytics:** Usage patterns, Debugging, Performance Profiling, Use Cases.	

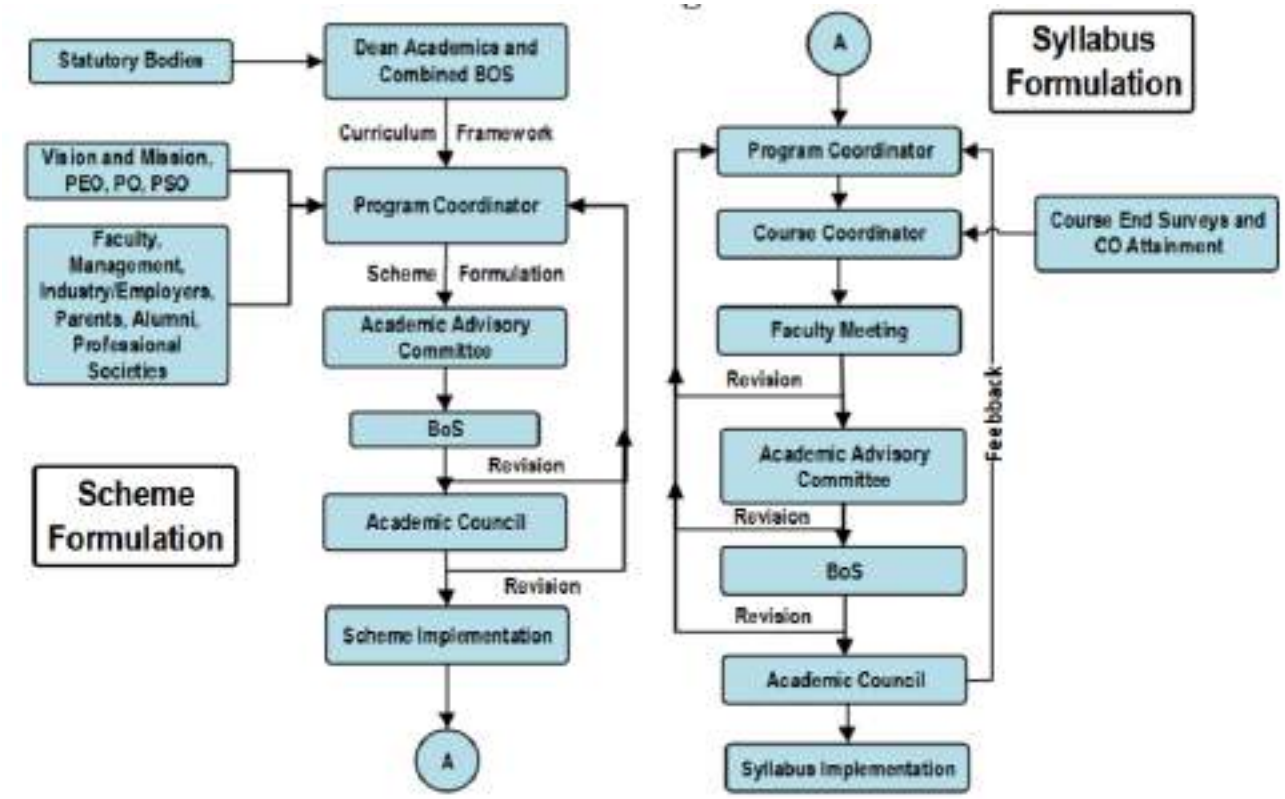
Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understanding the application of HMIs in various domain
CO2	Comparison of various communication protocols used in HMI development.
CO3	Apply and Analyse the car multimedia system free software and hardware evolution
CO4	Design and Evaluate the graphic tools and advanced techniques for creating car dashboard multimedia systems

Reference Books	
1.	Shuo gao, Shuo Yan, Hang Zhao, Arokia Nathan " Touch based HMI; Principles and Applications" Springer Nature Switzerland AG, 1" Edition
2.	Robert Wells, " Unity 2020 by Example: A Project based guide to building 2D, 3D augumented reality and Virtual reality games from sratch" Packt Publishing ltd , edition 2020
3.	Ryan Cohen, Tao Wang, "GUI Design and Android Apps" Apress, Berkley, CA,20l4

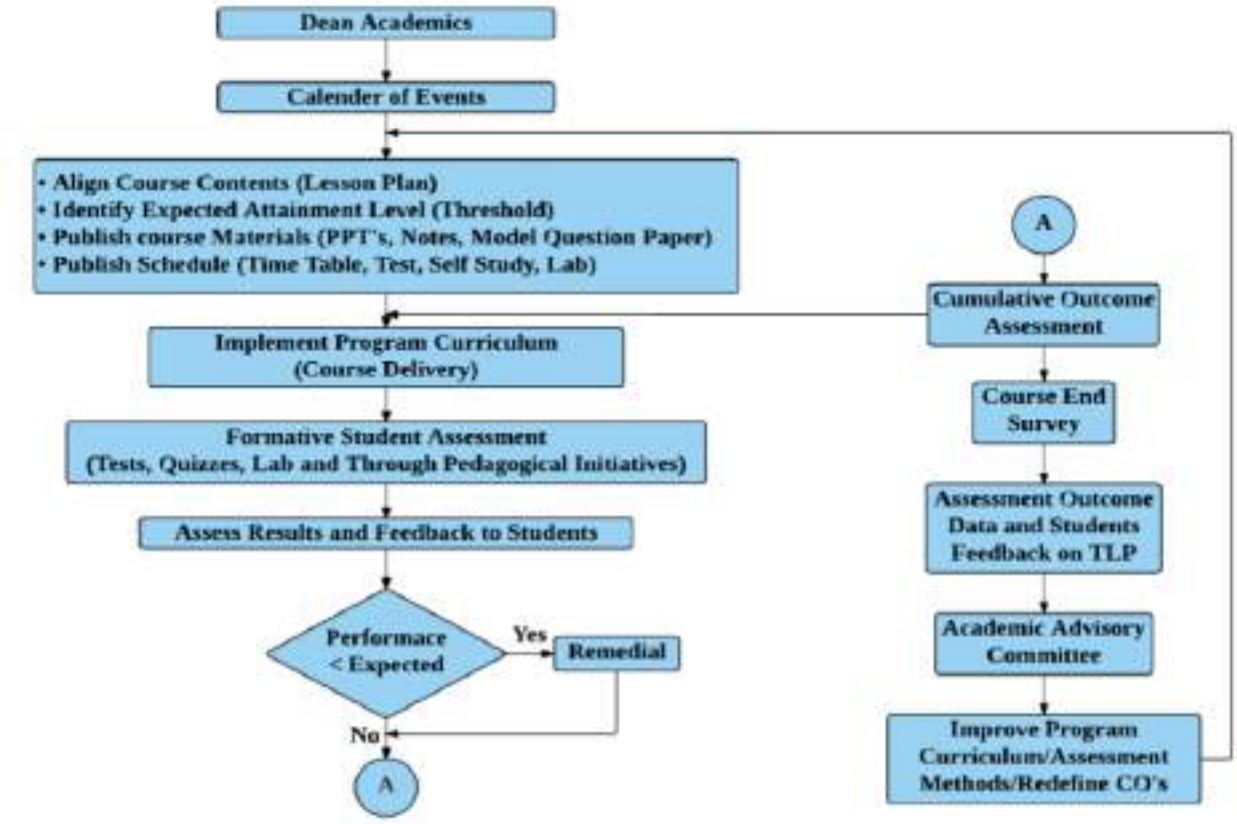
RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students 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
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

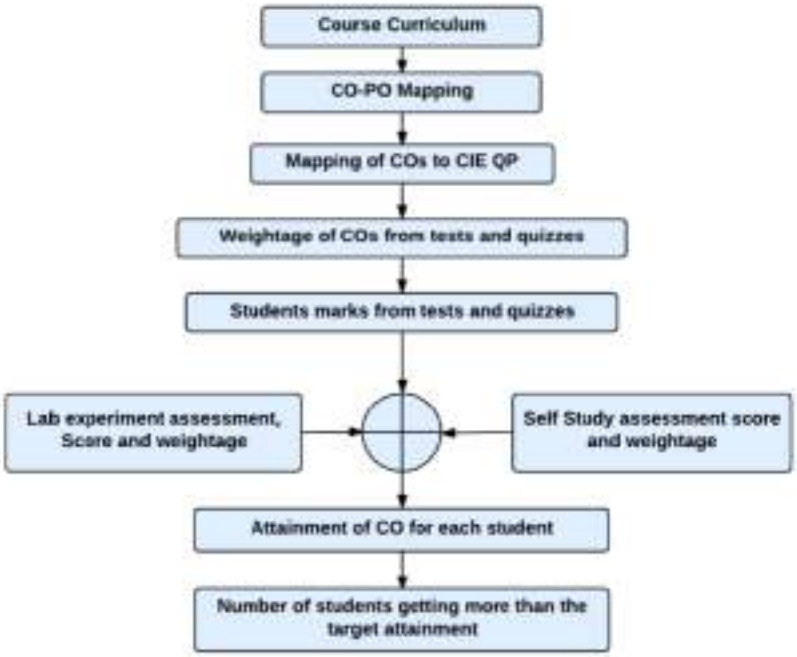
Curriculum Design Process



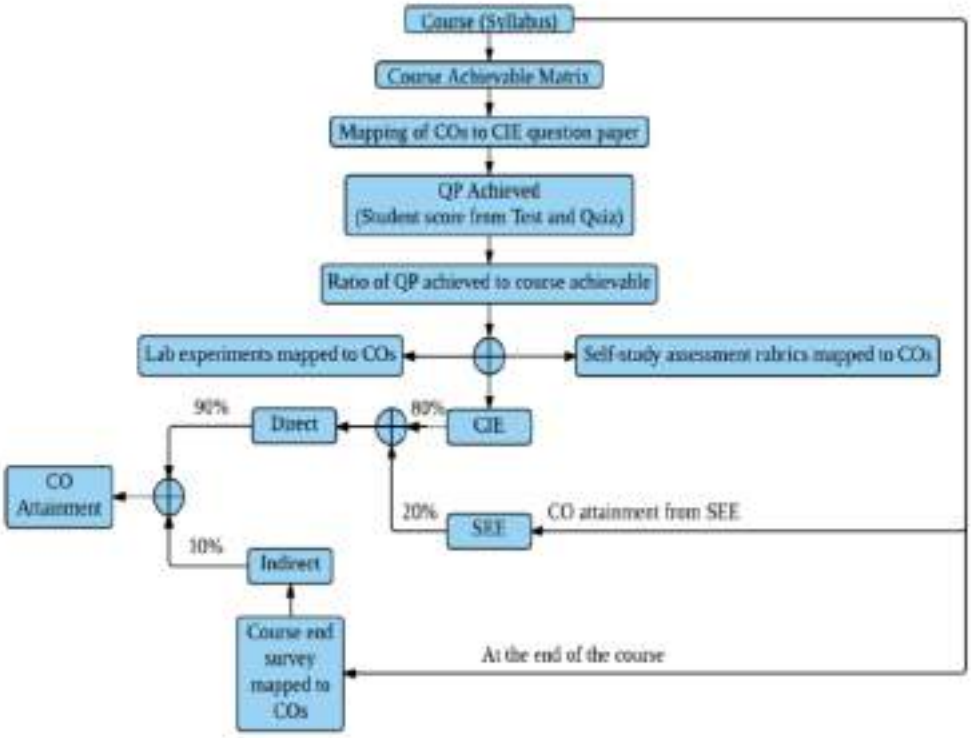
Academic Planning and Implementation



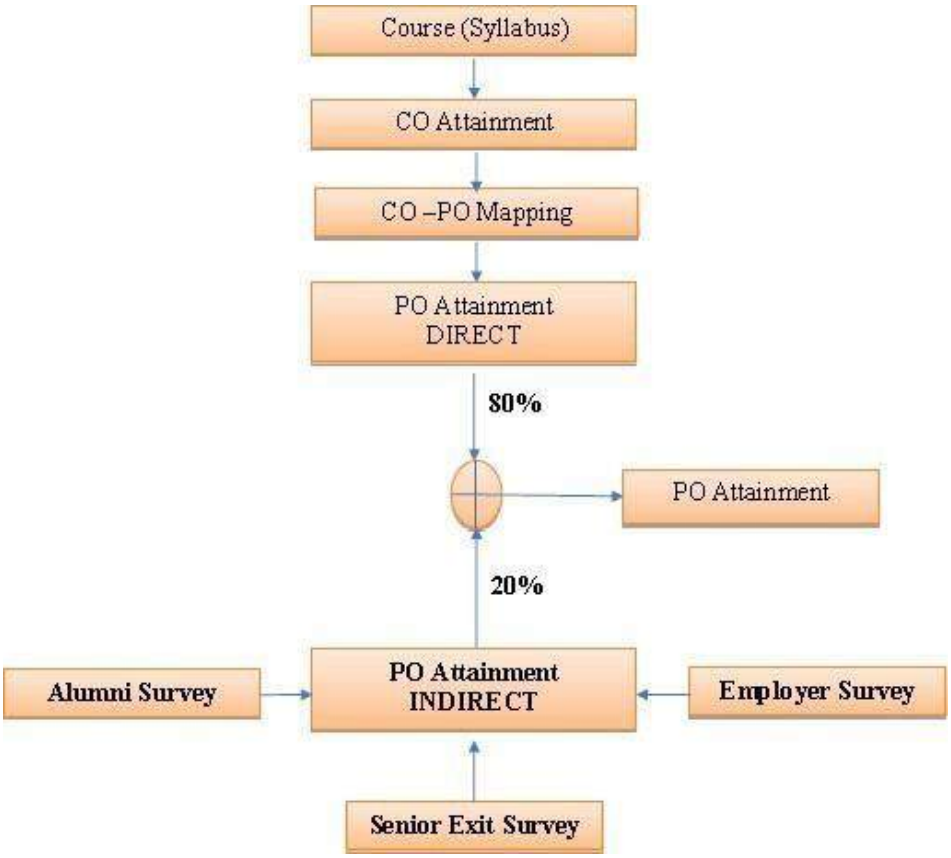
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcomes (POs) Attainment Process



PROGRAM OUTCOMES (POs)

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

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

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

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

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

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

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

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

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

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

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

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