V - VIII Semester
Scheme & Syllabus
(2021-22)
Department of
Artificial Intelligence
& Machine Learning

SCHEME AND SYLLABUS

GLOBAL ACADEMY OF TECHNOLOGY
Autonomous institution affiliated to VTU,
Belagavi.
Accredited by NAAC with 'A' grade,
Ideal Homes Township,
Raja Rajeshwari Nagar, Bengaluru-560098

V SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21AML51	Computer Network	PC	Respective Department	2	2	0	50	50	100	3
2	21AML52	Big data Analytics	IPC		3	0	2	50	50	100	4
3	21AML53	Deep Learning Principles & Practices	IPC		3	0	2	50	50	100	4
4		**Program Elective 1**	PEC		3	0	0	50	50	100	3
	21AML541	Computer Organization and Architecture									
	21AML542	Microcontroller and Embedded System									
	21AML543	Fundamentals of Data Science									
5	21AML55	Research Methodology	AEC		2	2	0	50	50	100	3
6	21AML56	AI Tools, Frameworks & its Application II			1	0	2	50	50	100	1
7	21CIV57	Environmental Science	CV	Civil	1	0	0	50	50	100	1
	OR										
	21UHV57	Universal Human Values	BS	Respective Department							
TOTAL								**350**	**350**	**700**	**19**

Program Elective 1*			
21AML541	Computer Organization & Architecture	22AML543	Fundamentals of Data Science
21AML542	Microcontroller and Embedded System		

***NPTEL for Credit transfer**: Students can take 12 weeks NPTEL course as an equivalent to Program elective. The NPTEL courses of duration less than 12 weeks will not be considered for credit transfer. The courses (only technical) taken are as per the recommendation of BOS of respective department. The similarity of the contents as offered by NPTEL should not exceed a maximum of 40% of the courses being registered by the student. The NPTEL course need to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not be considered. The validity of NPTEL certificate is for two years and it cannot be used more than once to avail the benefit. The student is eligible to transfer a maximum of nine credits in the entire duration of the program. The grades will be awarded as equivalent to the grades obtained in the NPTEL course.

Dean Academic
Global Academy of Technology,
Rajarajeshwarinagar, Bengaluru-98

Professor & Head
Dept. of Artificial Intelligence
& Machine Learning
Global Academy of Technology
Bengaluru

VI **SEMESTER**

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21AML61	Cyber Security	PC	Respective Department	2	2	0	50	50	100	3
2	21AML62	Image Processing with Computer Vision	IPC		3	0	2	50	50	100	4
3	21AM 63	Cloud Computing	IPC		3	0	2	50	50	100	4
4		**Program Elective 2**	PEC		2	2	0	50	50	100	3
	21AML641	Parallel and Distributed computing									
	21AML642	Intelligent Embedded System									
	21AML643	AI in Blockchain									
5		**Open Elective 1**	OEC	Offering Department	3	0	0	50	50	100	3
	21AML651	Computer Organization									
	21AML652	Basics of Designing of Algorithms									
6	21CIV66	Environmental Science	HSM	Civil	1	0	0	50	50	100	1
	OR										
	21UHV66	Universal Human Values	BS	Respective Department							
7	21AMLMP67	Mini Project	MP	Respective Department	Two Contact hours per week			50	50	100	2
							TOTAL	**350**	**350**	**700**	**20**

Program Elective 2*			
21AML641	Parallel and Distributed computing	21AML643	AI in Blockchain
21AML642	Intelligent to embedded system.		
Open Elective 1 (Offered to other branch students)			
21AML651	Computer Organization	21AML653	
21AML652	Basics of Designing of Algorithms		

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GLOBAL ACADEMY OF TECHNOLOGY

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Approved by AICTE, Accredited by NAAC,'A' Grade,
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Department of Artificial Intelligence & Machine Learning

SEMESTER –V

COMPUTER NETWORKS

Semester:	**5**	**CIE Marks**	**50**
Course Code	**21AML51**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PC**	**Credits**	**03**

Prerequisites (if any): No

Course Learning Objectives: Upon successful completion of this course, student will be able to

Sl. No	Course Learning Objectives (CLO)
1	Fundamentals of data communication networks.
2	Software and hardware interfaces
3	Application of various physical components and protocols
4	Communication challenges and remedies in the networks

Module 1	No. of Hours	RBT Level
Introduction to networks: Network hardware, Network software, Reference models, Physical Layer: Guided transmission media, Wireless transmission.	08	L2
Module 2		
The Data link layer: Design issues of DLL, Error detection and correction, Elementary data link protocols, Sliding window protocols. The medium access control sublayer: The channel allocation problem, Multiple access protocols.	08	L2
Module 3		
The Network Layer: Network Layer Design Issues, Routing Algorithms, Congestion Control Algorithms, QoS.	08	L2
Module 4		
The Transport Layer: The Transport Service, Elements of transport protocols, Congestion control, The internet transport protocols.	08	L2
Module 5		
Application Layer: Principles of Network Applications, The Web and HTTP, Electronic Mail in the Internet, DNS—The Internet's Directory Service.	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Learn the basic needs of communication system.
CO2	Interpret the communication challenges and its solution.
CO3	Identify and organize the communication system network components
CO4	Design communication networks for user requirements

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	2	0	0	0	0	0	0	0	0	0	0	1	1	0
CO2	2	2	0	0	1	0	0	0	0	0	0	1	1	0
CO3	2	2	1	0	1	1	0	0	0	0	0	1	1	0
CO4	2	3	2	0	2	1	0	0	0	0	0	1	1	0
Average	2	2	2	0	1	0.5	-	-	-	-	-	1	1	0

High-3: Medium-2: Low-1

Textbooks:

1. Computer-Networks- Andrew S. Tanenbaum and David J. Wetherall, Pearson Education, 5th-Edition.(www.pearsonhighered.com/tanenbaum)
2. Computer Networking A Top-Down Approach -James F. Kurose and Keith W. Ross Pearson Education 7th Edition.

Reference Books:

1. Behrouz A Forouzan, Data and Communications and Networking, Fifth Edition, McGraw Hill,Indian Edition
2. Larry L Peterson and Brusce S Davie, Computer Networks, fifth edition, ELSEVIER

E-Books / Web References:

Weblinks and Video Lectures (e-Resources):

1. https://www.digimat.in/nptel/courses/video/106105183/L01.html
2. http://www.digimat.in/nptel/courses/video/106105081/L25.html
3. https://nptel.ac.in/courses/106105081

MOOCs:

1) https://learn.saylor.org/course/CS402
2) https://www.coursera.org/specializations/computer-communications

Scheme of Examination (CIE):

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Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical evaluation pattern for regular courses is shown in Table 1:

	Components	Marks	Total
CIE	CIE TEST 1	40	50
	CIE TEST 2	40	
	CIE TEST 3	40	
	Assignment	10	
SEE	SEE	Semester End Exam	50
		Grand Total	100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

BIG DATA ANALYTICS

Semester:	5	CIE Marks	50
Course Code	21AML52	SEE Marks	50
Hours/Week (L: T: P)	3:0:2	Duration of SEE (hours):	03
Type of Course	IPC	Credits	04

Prerequisites (if any): Unix Commands, Unix Operating System, Python, Java

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Understand the importance of big data technologies used for storage, analysis, and manipulation ofdata.
2	Analyze and explore the Hadoop framework and Hadoop Distributed File system
3	Understand various tools like Hive and Pig for Big Data Analytics.
4	Provide insights into Hadoop framework and management functionalities.
5	Provide exposure to Hadoop ecosystem tools and techniques for big data processing.

Module 1	No. of Hours	RBT Level
Introduction to Big Data Analytics: Big Data, Scalability and Parallel Processing, Designing Data Architecture, Data Sources, Quality, Pre-Processing and Storing, Data Storage and Analysis. **SLT**: Applications of Big Data in the real world.	10	L2
Module 2		
Introduction to Hadoop: Introduction, Hadoop and its Ecosystem, Hadoop Distributed File System, MapReduce Framework and Programming Model, Hadoop Yarn, Hadoop Ecosystem Tools. **Hadoop Distributed File System Basics:** HDFS Design Features, Components SLT: HDFS User Commands.	10	L3
Module 3		
NoSQL Big Data Management, MongoDB and Cassandra: Introduction, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks, MongoDB, Databases. SLT: Cassandra Databases.	10	L3
Module 4		
MapReduce, Hive and Pig: Introduction, MapReduce Map Tasks, Reduce Tasks and MapReduce Execution, Composing	10	L3

MapReduce for Calculations and Algorithms, Hive, HiveQL. **SLT**: Pig		
Module 5		
Spark: Installing Spark, An Example: Spark Applications, Jobs, Stages, and Tasks, A Scala Standalone Application, A Java Example, A Python Example, Resilient Distributed Datasets: Creation, Transformations and Actions, Persistence, Serialization, Shared Variables: Broadcast Variables, Accumulators, Anatomy of a Spark Job: Run: Job Submission, DAG Construction. **SLT**: Task Scheduling, Task Execution. **Textbook 2**: Ch: 1	**10**	**L3**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	**Understand** the fundamentals of Big Data analytics
CO2	**Apply** the concept of HDFS, Map reduce for storing and processing of big data
CO3	**Demonstrate** the use of any modern Hadoop tool in team or individually to perform the data analytics
CO4	**Evaluate** the performance and efficiency of the installed tools and platform
CO5	**Develop** advanced Big Data programs that solve specific data processing challenges.

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	2	1		1	1			2		2			2	
CO2	3	1		0	3			2		2			2	
CO3	3	1		3	3			2		2			2	
CO4	3	1		3	3			2		2			2	
CO5	3	1		1	3			2		2			2	
Average	2.8	1		2.33	2.6			2		2			2	

High-3: Medium-2: Low-1

Textbooks:

1. Raj Kamal, Preeti Saxena, "Big Data Analytics, Mc graw Hill, 2019
2. Tom White, Hadoop: The Definitive Guide, 4th edition, O'Reilly.

Reference Books:

1. Big Data: Black Book, DT Editorial Services, Wiley India Pvt Ltd, 2016 Edition
2. Arshdeep Bahga, Vijay Madisetti, "Big Data Analytics: A Hands-On Approach", 1st Edition, VPT Publications, 2018. ISBN-13: 978-0996025577
3. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
4. Tom White, Hadoop: The Definitive Guide, O'Reilly Media, Third Edition, 2012.
5. Dan C. Marinescu, Cloud Computing Theory and Practice, Morgan Kaufmann, Elsevier 2013.
6. Mining of massive Dataset , by Jure Leskovec , Anand Rajaraman , Jeffrey David Ullman ,Stanford University, 3rd Edition.

E-Books / Web References:

1. Big Data Now http://cdn.oreillystatic.com/ oreilly/radarreport/ 0636920028307/ Big_Data_Now_2012_ Edition.pdf
2. Bigdata Analytics with Hadoop: https://www.packtpub.com/free-ebook/big-data-analytics-with-hadoop-3/9781788628846

MOOCs:

1. Big Data Computing, IIT Patna, https://nptel.ac.in/courses/106104189
2. https://apps.cognitiveclass.ai/learning/course/course-v1:BDU+BD0133EN+v1/home
3. https://www.udemy.com/course/the-ultimate-hands-on-hadoop-tame-your-big-data/

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Typical evaluation pattern for regular courses is shown in Table 1:

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

DEEP LEARNING PRINCIPLES & PRACTICES

Semester:	5	CIE Marks	50
Course Code	21AML53	SEE Marks	50
Hours/Week (L: T: P)	3:0:2	Duration of SEE (hours):	03
Type of Course	IPC	Credits	04

Prerequisites (if any): Machine Learning Essentials, Python Programming, Linear Algebra.

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Understand the fundamental concepts of deep feedforward networks, including multilayer perceptron, gradient-based learning, and the back-propagation algorithm
2	Apply deep feedforward networks to practical problems by designing network architectures and hidden units, with a focus on learning the XOR problem as an example
3	Analyze convolutional networks, including the convolution operation, pooling, and their role as strong priors in image processing, while exploring efficient convolution algorithms
4	Investigate auto encoders and their various types, such as under complete, denoising, and contractive auto encoders, along with practical applications

Module 1	No. of Hours	RBT Level
Fundamentals of Neural Networks: Introduction, Understanding the Biological Neuron. Exploring the Artificial Neurons, Early Implementation of ANN, Types of Activation Function. Architectures of Neural Networks, Learning process in ANN.	10	L2
Module 2		
Training Deep Neural Networks: Introduction, Mathematics Behind Backpropagation, DeepLlayer Neural Network, Understanding the notion of forward and backward propagation, Initializing weights in Neural Network, Batch, Mini-batch and stochastic Gradient Descent.	10	L2
Module 3		
Convolutional Neural Networks: How computers sees the world, Challenges faced by Traditional ANN to work with Image Data, Building blocks of CNN, Building a CNN, Popular Carchitectures.	10	L3

Module 4		
Sequence-based Models: Introduction to Sequence Data, Recurrent Neural Networks, Long Short-term Memory, Gated Recurrent Units, Bi-directional Models.	10	L3
Module 5		
Encoder-Decoder Architecture, Attention Mechanism, Transformer Architecture, Genera Adversarial Networks.	10	L3

Course Outcomes:

Upon successful completion of this course, students will be able to

CO No.	DEEP LEARNING PRINCIPLES & PRACTICES-21AML53	RBT Level / Cognitive Level
CO53.1	Understand and Analyse the fundamentals that drive deep learning networks	L2
CO53.2	Build, train and apply fully connected neural networks	L3
CO53.3	Analyse convolutional networks and their role in image processing.	L3
CO53.4	Implementation of deep learning techniques to solve real-world problems.	L5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO53.1	3	3	3	-	2	-	-	-	-	1	-	2	-	2
CO53.2	2	3	2	-	2	-	-	-	-	1	-	2	-	2
CO53.3	2	2	2	-	3	-	-	-	-	1	-	2	-	2
CO53.4	2	2	3	-	3	-	-	-	-	1	1	2	-	2

Text Books:

1. "Deep Learning", Amit kumar das, Saptarsi goswami, Pabitra mitra, Amlan, 1st edition, Pearson.

Reference Books:

1. Deep Learning", Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press, 2017.
2. "Deep Learning: A Practitioner's Approach" Josh Patterson, Adam Gibson, O'Reilly Media, 2017
3. "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Umberto Michelucci Apress, 2018.
4. "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy The MIT Press, 2012.
5. "Introduction to Machine Learning", EthemAlpaydinMIT Press, Prentice Hall of India, Third Edition 2014.
6. "Deep Learning with TensorFlow: Explore neural networks with Python", Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy Packt Publisher, 2017.
7. "Deep Learning with Keras", Antonio Gulli, Sujit Pal Packt Publishers, 2017.
8. "Deep Learning with Python", Francois Chollet Manning Publications, 2017.

E-Books / Web References:

1. https://github.com/janishar/mit-deep-learning-book-pdf
2. https://www.cse.iitk.ac.in/users/sigml/lec/DeepLearningLib.pdf

MOOCs:

1. https://www.simplilearn.com/introduction-to-deep-learning-free-course-skillup
2. https://www.udemy.com/course/the-complete-deep-learning-course/

Mode of Evaluation: LAB			
Prog No.	Integrated component of Professional Course (IPC-Practical)- **List of Indicative Program Description**	**CO**	**RBT Level**
	Part - A		
1.	Implementation of Artificial neural network for classification.	CO1	L3
2.	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.	CO2	L3
3.	Develop a baseline neural network model for the regression problem. (for Boston house price dataset)	CO1	L3
4.	Apply deep feedforward networks to practical problems by designing network architectures and hidden units, with a focus on learning the XOR problem as an example.	CO2	L3
5.	Convolutional Neural Networks Best Practices To Develop a deep learning model to achieve near state-of-the-art performance on the MNIST handwritten digit recognition task in Python using the Keras deep learning library	CO3	L4

Prog No.	**Additional Programs**	**CO**	**RBT Level**
	Part – B		
6.	Perform Sentiment Analysis in network graph using RNN	CO3	L5
7.	Image Captioning using Deep Learning	CO4	L5
8.	Generating cifar-10 fake images using Deep Convolutional Generative Adversarial Networks (DCGAN)	CO4	L5

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	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

COMPUTER ORGANIZATION AND ARCHITECTURE

Semester:	**5**	**CIE Marks**	**50**
Course Code	**21AML541**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites (if any): Basic knowledge prior to Computer Architecture, basic functional units of a computer system and Number system.

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Understand the organization and architecture of computer systems, their structure and operation.
2	Illustrate the concept of machine instructions and programs.
3	Demonstrate different ways of communicating with I/O devices.
4	Describe different types memory devices and their functions
5	Explain arithmetic and logical operations with different data types.
6	Demonstrate processing unit with parallel processing and pipeline architecture.

Module 1	No. of Hours	RBT Level
Basic Structure of Computers: Basic Operational Concepts, Bus Structures, Performance – Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement. **Machine Instructions and Programs**: Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes.	08	L2
Module 2		
Input / Output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Direct Memory Access, Buses, Interface Circuits.	08	L2
Module 3		
Memory System: Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed, Size, and Cost, Cache Memories – Mapping Functions, Virtual memories	08	L2

Module 4		
Arithmetic: Numbers, Arithmetic Operations and Characters, Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers. **Basic Processing Unit:** Fundamental Concepts, Execution of a Complete Instruction, Hardwired control, Microprogrammed control.	08	L3
Module 5		
Pipeline and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Vector Processing, Array Processors.	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Explain the organization and architecture of computer systems with machine instructions and programs.
CO2	Analyze the input/output devices communicating with computer system.
CO3	Demonstrate the functions of different types of memory devices.
CO4	Apply different data types on simple arithmetic and logical unit.
CO5	Analyze the functions of basic processing unit, Parallel processing and pipelining.

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	3	2	1					3		1		2	2	
CO2	2	2	1					3		1		2	2	
CO3	3	2	1					3		1		2	2	
CO4	2	3	2					2		1		2	2	
Avg.	2.5	2.25	1.25					2.75		1		2	2	

High-3: Medium-2: Low-1

Text Books:

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, 5th Edition,Tata McGrawHill .
2. M. Morris Mano, Computer System Architecture, PHI, 3rd Edition

Reference Books:

1. William Stallings: Computer Organization & Architecture, 9th Edition, Pearson, 2015.

E-Books / Web References:

1. https://passlab.github.io/CSCE513/resources/
2. https://gateoverflow.in/blog/9728/some-good-resources-for-computer-organisation- architecture.
3. https://www.tutorialspoint.com/computer_logical_organization/computer_logical_organization_useful_resources.htm

MOOCs:

1. https://www.udemy.com/course/computer-organization-and-architecture-j/?
2. https://nptel.ac.in/courses/106/103/106103068/

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Typical evaluation pattern for regular courses is shown in Table 1:

	Components	Marks	Total
CIE	CIE TEST 1	40	50
	CIE TEST 2	40	
	CIE TEST 3	40	
	Assignment	10	
SEE	SEE	Semester End Exam	50
		Grand Total	100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

MICROCONTROLLER AND EMBEDDED SYSTEMS

Semester:	**5**	**CIE Marks**	**50**
Course Code	**21AML542**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites: Basic understanding of digital and analog circuits, C programming skills.

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Understand the fundamentals of ARM-based systems, including programming modules with registers and the CPSR.
2	Use the various instructions to program the ARM controller.
3	Program various embedded components using the embedded C program
4	Identify various components, their purpose, and their application to the embedded system's applicability.
5	Understand the embedded system's real-time operating system and its application in IoT.

Module 1	No. of Hours	RBT Level
Microprocessors versus Microcontrollers, ARM Embedded Systems: The RISC design philosophy, The ARM Design Philosophy, Embedded System Hardware, Embedded System Software. **ARM Processor Fundamentals:** Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Core Extensions	8	**L2**
Module 2		
Introduction to the ARM Instruction Set: Data Processing Instructions, Branch Instructions, Software Interrupt Instructions, Program Status Register Instructions, Coprocessor Instructions, Loading Constants. **C Compilers and Optimization:** Basic C Data Types, C Looping Structures, Register Allocation, Function Calls, Pointer Aliasing	8	**L2**
Module 3		
C Compilers and Optimization: Structure Arrangement, Bit-fields, Unaligned Data and Endianness, Division, Floating Point, Inline Functions and Inline Assembly, Portability Issues. **ARM programming using Assembly language:** Writing Assembly code, Profiling and cycle counting, instruction scheduling, Register Allocation, Conditional Execution, Looping Constructs	8	**L3**
Module 4		

Embedded System Components: Embedded Vs General computing system, History of embedded systems, Classification of Embedded systems, Major applications areas of embedded systems, purpose of embedded systems.Core of an Embedded System including all types of processor/controller, Memory, Sensors, Actuators, LED, 7 segment LED display, stepper motor, Keyboard, Push button switch, Communication Interface (onboard and external types), Embedded firmware, Other system components.	8	**L3**
Module 5		
RTOS and IDE for Embedded System Design: Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Multiprocessing and Multitasking, Task Communication (without any program), Task synchronization issues – Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program), How to choose an RTOS, Integration and testing of Embedded hardware and firmware, Embedded system Development Environment – Block diagram (excluding Keil), Disassembler/decompiler, simulator, emulator and debugging techniques, target hardware debugging, boundary scan.	8	**L3**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Explain C-Compilers and optimization
CO2	Describe the ARM microcontroller's architectural features and program module.
CO3	Apply the knowledge gained from programming on ARM to different applications.
CO4	Program the basic hardware components and their application selection method.
CO5	Demonstrate the need for a real-time operating system for embedded system applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	0	0	0	0	0	0	0	0	0	1	3	1
CO2	3	1	0	0	0	0	0	0	0	0	0	1	3	1
CO3	3	3	3	3	3	0	0	0	0	0	0	1	3	1
CO4	3	3	3	3	3	0	0	0	0	0	0	1	3	1
CO5	3	3	3	3	3	0	0	0	0	0	0	1	3	1

High-3: Medium-2: Low-1

Text Book:

1. Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide, Elsevier, Morgan Kaufman publishers, 2008.
2. Shibu K V, Introduction to Embedded Systems, Tata McGraw Hill Education, Private Limited, 2nd Edition.

Reference Books:

1. Raghunandan. G.H, Microcontroller (ARM) and Embedded System, Cengage learning Publication,2019
2. The Insider's Guide to the ARM7 Based Microcontrollers, Hitex Ltd.,1st edition, 2005.
3. Steve Furber, ARM System-on-Chip Architecture, Second Edition, Pearson, 2015.
4. Raj Kamal, Embedded System, Tata McGraw-Hill Publishers, 2nd Edition, 2008

E-Books / Web References:

1. https://archive.nptel.ac.in/courses/106/105/106105193/
2. NPTEL Lecture https://nptel.ac.in/courses/microcontroller

Scheme of Examination (CIE):

In order to encourage innovative methods while delivering a course, the faculty members have beenencouraged to use the **Alternative Assessment Tool (AAT).** The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices.

Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.Typical evaluation pattern for regular courses is shown in Table 1:

	Components	Marks	Total
CIE	CIE TEST 1	40	50
	CIE TEST 2	40	
	CIE TEST 3	40	
	Assignment	10	
SEE	SEE	Semester End Exam	50
		Grand Total	100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionatelyreduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

FOUNDATIONS OF DATA SCIENCE

Semester:	**5**	**CIE Marks**	**50**
Course Code	**21AML543**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To provide fundamental knowledge on data science with querying and analytics required for the field of data science.
2	To understand the process of handling heterogeneous data, pre-process and visualize them for better understanding
3	To gain the fundamental knowledge on data science tools and gain basic skill set to solve real-time data science problems.

Module 1	No. of Hours	RBT Level
Data Science Context: Need for Data Science – What is Data Science - Where Do We See Data Science? , How Does Data Science Relate to Other Fields The Relationship between Data Science and Information Science, Computational Thinking, Skills for Data Science. **Data:** Introduction, Data Types, Data Collections, Data Pre-processing	8	L2
Module 2		
Platform for Data Science: Python for Data Science –Python Libraries – Data Frame Manipulation with numpy and pandas – Exploration Data Analysis – Time Series Dataset – Clustering with Python – Dimensionality Reduction.	8	L2
Module 3		
Basics of Statistics: Introduction to Statistics, Terminologies in Statistics, Measures of center, variance and relative standing, Normalization of data using the Z-Score, Empirical rule, Categories in Statistics (Descriptive and Inferential Statistic). **Descriptive Statistics:** Data Objects and Attributes, Basic Statistical Description of data (Measuring the central Tendency of data, Measuring the Dispersion of data, Graphical Display), Measuring the Data Similarity and Dissimilarly.	8	L3
Module 4		
Inferential Statistics: Overview of Probability Distribution (Bernoulli, Binomial, Poisson, Chi-		

Square, t-tail), Joint distribution of the Sample Mean and Sample Variance, Confidence Intervals, Bayesian Analysis of samples from Normal distribution. **Linear Algebra for Data Science:** Basics of Matrices, Matrices and Systems of Linear Equations, Matrix algebra and operations, Determinants of Matrix, Properties of Determinants.	8	**L3**
Module 5		
Data Wrangling: Understanding Data - The Data Generation Process - Finding Data - Types of Data - Interpreting Data - Using Data to Answer Questions - Data Frames - Working with Data Frames -Working with CSV Data. **Machine Learning algorithms for Data science**. (Regression, kNN, Decision tree, SVM) **Data Visualization Techniques and Tools:** Line Chart, Histograms, Pie chart, scatterplot, Bar chart, Box plot, Heat map, Tableau Visualization tool.	8	**L3**

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1	**Use** fundamental knowledge of data science.
CO2	**Demonstrate** proficiency in data analytics
CO3	**Formulate** insights from the data through statistical inferences.
CO4	**Apply** advanced tools to work on dimensionality reduction and mathematical operations.
CO5	**Demonstrate** numerous open-source data science tools to solve real-world problems through industrial case studies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-								2	2
CO2	-	3	2	2	3						2		2	2
CO3	3	2	3	2	3						2		2	2
CO4	2	2	2	2	3						2		2	2
CO5	-	-	2	2	3					3	3		2	2

High-3: Medium-2: Low-1

Text Book:

1. Michael Freeman and Joel Ross, Programming Skills for Data Science: Start Writing Code to Wrangle, Analyze, and Visualize Data with R, Addison-Wesley, 2018.
2. Sanjeev Wagh, Manisha Bhende, Anuradha Thakare, 'Fundamentals of Data Science, CRC Press, 1st Edition, 2022.
3. CHIRAG SHAH, A Hands-On Introduction to Data Science, Cambridge University Press, 1st Edition, 2020.

4. Mike X Cohen, Practical Linear Algebra for Data Science, O'Reilly Media, Inc 2022.

Reference Books:

1. Benjamin S. Baumer, Daniel T. Kaplan and Nicholas J. Horton, Modern Data Science with R, Chapman and Hall/CRC, 2021
2. John Mount and Nina Zumel, Practical Data Science with R, 2 nd edition, Wiley, 2019.E

Books / Web References:

1. What Is Data Visualization? Definition & Examples | Tableau

Scheme of Examination (CIE):

In order to encourage innovative methods while delivering a course, the faculty members have been encouraged to use the **Alternative Assessment Tool (AAT).** The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices.

Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a- thon conducted by reputed organizations/ any other.

Typical evaluation pattern for regular courses is shown in Table 1:

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

RESEARCH METHODOLOGY

Semester:	**5**	**CIE Marks**	**50**
Course Code	**21AML55**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**Duration of SEE (hours):**	**03**
Type of Course	**AEC**	**Credits**	**03**

Prerequisites (if any): None

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Define research and identify the systematic steps to be followed.
2	Identify the overall process of designing a research study from inception to its report
3	Impart familiarity with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.

Module 1	No. of Hours	RBT Level
An Introduction: Meaning, Objectives and Characteristics of research - Research methods Vs Methodology -Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research. **Defining the Research Problem:** Definition of Research Problem, Selecting the Problem, Necessity of Defining the Problem Technique Involved in Defining a Problem.	08	L2
Module 2		
Research Design: Research design and methods – Research design – Basic Principles- Need of research design —Features of good design – Important concepts relating to research design- Different research Design- Developing a research plan.	08	L2
Module 3		
Sampling design - Steps in sampling design - Characteristics of a good sample design - Types of sample designs - **Methods of data collection:** Collection of Primary Data, Observation Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Collection of Secondary Data.	08	L2

Module 4		
Testing of hypotheses - Basic concepts - Procedure for hypotheses testing, flow diagram for hypotheses testing, Important parametric test - Chi-square test.	08	L3
Module 5		
Interpretation and report writing - Techniques of interpretation - Structure and components of scientific reports - Different steps in the preparation - Layout, structure and language of the report - Illustrations and tables - Types of report - Technical reports and thesis	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Understand some basic concepts of research and its methodologies.
CO2	Explain the methods of data collection.
CO3	Identify appropriate research topics.
CO4	Select and define appropriate research problem and parameters.
CO5	Prepare a project proposal (to undertake a project)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		1				1	1	1	2	2		2	-	-
CO2		1	1			1	1	1	2	2		2	-	-
CO3		1	1			1	1	2	3	2		2	-	-
CO4		1	1			1	1	2	3	3	1	2	-	-
CO5		1	1			1	1	2	3	3	1	2	-	-
Average		1	0.8			1	1	1.6	2.6	2.4	0.4	2		

High-3: Medium-2: Low-1

Text Books:

1. "Research Methodology: Methods and Techniques", C R Kothari, Gourav Garg, New Age International Publishers, 3rd Edition, 2014.

Reference Books:

1. "Research Methods for Engineers", David V Thiel, Cambridge University Press, 2014.

E-Books / Web References:

1. https://ccsuniversity.ac.in/bridge-library/pdf/Research-Methodology-CR-Kothari.pdf
2. https://research.com/research/how-to-write-research-methodology
3. https://gradcoach.com/what-is-research-methodology/

MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_ge08/preview
2. https://www.coursera.org/learn/research-methodologies

Scheme of Examination (CIE):

In order to encourage innovative methods while delivering a course, the faculty members have been encouraged to use the **Alternative Assessment Tool (AAT).** The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices.

Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ conceptvideos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical evaluation pattern for regular courses is shown in Table 1:

	Components	Marks	Total
CIE	CIE TEST 1	40	50
	CIE TEST 2	40	
	CIE TEST 3	40	
	Assignment	10	
SEE	SEE	Semester End Exam	50
		Grand Total	100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.

The students will have to answer five full questions, selecting one full question from each module.

SEMESTER – V

ABILITY ENHANCEMENT COURSE – V

AI TOOLS, FRAMEWORKS & ITS FRAMEWORKS III

Semester:	**5**	**CIE Marks**	**50**
Course Code	**21AML56**	**SEE Marks**	**50**
Hours/Week (L:T:P)	**0:0:2**	**Duration of SEE (hours):**	**03**
Type of Course	**AEC**	**Credits**	**01**

Prerequisites: IoT

Course Learning Objectives: The course will enable students to:

CLO1	Understand the fundamental principles of AI and IoT technologies as applied to agriculture.
CLO2	Describe the role of AI and IoT in addressing sustainability challenges in urban environments.
CLO3	Investigate various AI and IoT applications in smart city initiatives.
CLO4	Develop the techniques of text preprocessing and data cleaning for natural language processing (NLP).

Sl.NO	Laboratory Experiments
	PART A
1	**AI in Agriculture** **Smart Irrigation System** Build a smart irrigation system using Arduino or Raspberry Pi that incorporates soil moisture sensors and weather data. They will develop an AI algorithm to optimize irrigation based on real-time conditions.
2	**AI in Smart Cities** **Smart Street Lighting with IoT** Design a smart street lighting system using Arduino or Raspberry Pi and IoT sensors to detect light levels and motion. They will develop an AI algorithm to optimize street lighting based on real-time conditions.
3	**AI in Education** **Recommendation System for Online Courses** Create a basic recommendation system using collaborative filtering with TensorFlow. Use it to recommend online courses to students based on their previous choices.
4	**AI in Healthcare** **Predicting Disease Outcomes from Patient Data** Build a predictive model using TensorFlow to estimate the progression of a specific disease (e.g., diabetes) based on patient data such as age, BMI, and blood sugar levels.
	PART B

	PART B
	Mini Project **1. Building a model for smart city using sensors.** **2. Building a model to solve traditional farming problems using AI.** **3. Building a model to solve Education problems using AI.** **4. Building a model to solve Healthcare problems using AI.**

Course Outcomes: Upon successful completion of this course, students will be able to

CO1	Students will explore AI and IoT's impact on Agricultural Innovation with AI and IoT.
CO2	Students will understand AI and IoT's role in Smart Solutions for Sustainable Urban Living.
CO3	Students will master text preprocessing, neural networks for sentiment analysis, and interpreting sentiment scores.
CO4	Students will appreciate AI's importance in diagnosing medical conditions.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1		3				2	2		1		1
CO2	1	2	1		3				2			1	1	1
CO3	2	2	1	1	3				2	3		1		2
CO4	2	2	1	1	3				2	3		1		2

High-3: Medium-2: Low-1

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Mini Project

1. Develop a mini project using the languages and concepts learnt in the theory and Exercises listed in part B with a good look and feel effects.
2. You can use any technologies and frameworks and databases.
3. However during the examination, each student must demonstrate the project individually.

Scheme of Examination (CIE):

In order to encourage innovative methods while delivering a course, the faculty members have been encouraged to use the Alternative Assessment Tool (AAT). The Subject treated as Laboratory with fixed experiment and mini-project so the CIE is Evaluated for 50 Marks and SEE is Evaluated for 50 Marks.

SEMESTER – V/VI

Course: Universal Human Values

Course Code	21UHV57/67	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	1	Examination Hours	1 hour

Course Learning Objectives:

CLO1	To create an awareness on Engineering Ethics and Human Values.
CLO2	To understand social responsibility of an engineer.
CLO3	To appreciate ethical dilemma while discharging duties in professional life.

Content	No. of Hours
Module 1 **Introduction to Value Education** • Value Education, Definition, Concept and Need for Value Education. • The Content and Process of Value Education. • Basic Guidelines for Value Education, • Self-exploration as a means of Value Education. • Happiness and Prosperity as parts of Value Education.	05 Hours
Module 2 **Harmony in the Human Being** • Human Being is more than just the Body. • Harmony of the Self ('I') with the Body. • Understanding Myself as Co-existence of the Self and the Body. • Understanding Needs of the Self and the needs of the Body. • Understanding the activities in the Self and the activities in the Body.	05 Hours
Module 3 **Harmony in the Family and Society and Harmony in the Nature** • Family as a basic unit of Human Interaction and Values in Relationships. • The Basics for Respect and today's Crisis: Affection, Guidance, Reverence, Glory, Gratitude and Love, • Comprehensive Human Goal: The Five Dimensions of Human Endeavour. • Harmony in Nature: The Four Orders in Nature. • The Holistic Perception of Harmony in Existence.	05 Hours
Module 4 **Social Ethics** • The Basics for Ethical Human Conduct, Defects in Ethical Human Conduct. • Holistic Alternative and Universal Order, • Universal Human Order and Ethical Conduct. • Human Rights violation and Social Disparities.	05 Hours
Module 5 **Professional Ethics** • Value based Life and Profession., Professional Ethics and Right Understanding. • Competence in Professional Ethics. • Issues in Professional Ethics – The Current Scenario. • Vision for Holistic Technologies • Production System and Management Models.	05 Hours

COURSE OUTCOMES: Upon completion of this course, student will be able to:

21UHV57.1/67.1	Understand the significance of value inputs in a classroom and start applying them intheir life and profession
21UHV57.2/67.2	Distinguish between values and skills, happiness and accumulation of physical facilities,the Self and the Body, Intention and Competence of an individual, etc.
21UHV57.3/67.3	Understand the role of a human being in ensuring harmony in society and nature.
21UHV57.4/67.4	Distinguish between ethical and unethical practices and start working out the strategy toactualize a harmonious environment wherever they work.

Textbooks:

1.A.N Tripathy, New Age International Publishers, 2003. 2.Bajpai.
B. L, New Royal Book Co, Lucknow, Reprinted, 2004 3.Bertrand
Russell Human Society in Ethics & Politics

Reference books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. Corliss Lamont, Philosophy of Humanism.
4. Gaur. R.R. , Sangal. R, Bagari G.P, A Foundation Course in Value Education,Excel Books, 2009.
5. Gaur. R.R. , Sangal R , Bagaria G.P, Teachers Manual, Excel Books, 2009.
6. I.C. Sharma, Ethical Philosophy of India, Nagin & co, Julundhar
7. William Lilly- Introduction to Ethics -Allied Publisher

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
	CIE Test-2	**50**	
SEE	Semester End Examination	**50**	**50**
		Grand Total	**100**

CO/PO Mapping																
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
21UHV57.1/67.1	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.2/67.2	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.3/67.3	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.4/67.4	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
Average	-	-	-	-	-	-	-	**2**	-	-	-	**1**	-	-	-	-

Low-1: Medium-2: High-3

SEMESTER – VI

CYBER SECURITY

Semester:	6	CIE Marks	50
Course Code	21AML61	SEE Marks	50
Hours/Week (L: T: P)	2:2:0	Duration of SEE (hours):	03
Type of Course	PC	Credits	03

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To understand various types of cyber-attacks and cyber-crimes
2	To learn threats and risks within the context of the cyber security
3	To have an overview of the cyber laws & concepts of cyber forensics
4	To study the defensive techniques against these attacks

Module 1	No. of Hours	RBT Level
Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.	08	L2
Module 2		
Cyberspace and the Law & Cyber Forensics: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics	08	L2
Module 3		
Cyber crime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational security Policies and Measures in Mobile Computing Era, Laptops. R1C3	08	L2
Module 4		
Cyber Security: Organizational Implications: Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security, and privacy implications, social media	08	L3

marketing: security risks and perils for organizations, social computing and the associated challenges for organizations. R1C9		
Module 5		
Privacy Issues: Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data-linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc. **Cases:** The Indian Case of Online Gambling, An Indian Case of Intellectual Property Crime, Financial Frauds in the Cyber Domain.R1C11	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Explain cyber-attacks, types of cybercrimes, cyber laws and also how to protect them self and ultimately the entire Internet community from such attacks.
CO2	Interpret and forensically investigate security incidents
CO3	Identify policies and procedures to manage Privacy issues
CO4	Design and develop secure software modules
CO5	Develop data privacy concepts used in cyber crime

CO/PO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	1	2						1		1		1	1	1
CO2	2	2	1	1				1		1		1	1	1
CO3	2	2	1	1				1		1		1	2	1
CO4	2	2	1	1				1		1		1	2	1
CO5	2	2	1	1				1		1		1	2	1

High-3: Medium-2: Low-1

Text Books:

1. "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives",Nina Godbole and SunitBelpure, Wiley
2. "Computer and Cyber Security:Principle s, Algorithm, Applications, and Perspectives", B.B.Gupta,D. P.Agrawal, Haoxiang Wang, , CRC Press, ISBN 9780815371335,2018.

Reference Books:

1. "Cyber Security Essentials, James Graham", Richard Howard and Ryan Otson, CRCPress.
2. "Introduction to Cyber Security", Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&FGroup

E-Books / Web References:

1. https://securityintelligence.com/free-ebook-practical-guide-to-staying-ahead-in-the-cyber-security-game/
2. https://www.pdfdrive.com/cyber-security-books.html

MOOCs:

1. https://www.cyberdegrees.org
2. https://www.udemy.com/course/complete cybersecurity

Scheme of Examination (CIE):

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Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical evaluation pattern for regular courses is shown in Table 1:

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

IMAGE ANALYTICS WITH COMPUTER VISION

Semester:	VI	CIE Marks	50
Course Code	21AML62	SEE Marks	50
Hours/Week (L: T: P)	3:0:2	Duration of SEE (hours):	03
Type of Course	IPC	Credits	04

Prerequisites (if any): Image Processing & Deep Learning

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
CLO1	To impart the fundamentals of image formation, the major ideas, methods, and techniques of computer vision and pattern recognition
CLO2	To understand the workings of Generative AI and the diffusion models.
CLO3	To develop an appreciation for various techniques of Computer Vision for Object detection and Face Recognition systems
CLO4	To provide the student with programming experience from implementing computervision and object recognition applications.

Module 1	No. of Hours	RBT Level
Introduction to Computer Vision Basic concepts: pixel representation of an image, Image in frequency domain, different color models, and their transformation, Filtering and Convolution, Image preprocessing using PIL/Pillow, OpenCV, and Keras: reading multiple images from a directory, plotting, enhancement,filtering, re-scaling, morphological operations and image data augmentation.	10	L2
Module 2		
Object Detection Basic concepts: bounding box representation, sliding window methods, anchorboxes, grid cells, and non-maximum suppression (NMS). State-of-the-artarchitectures: R-CNN and YOLO. Evaluation metrics: Intersection over Union (IoU) and Mean Average Precision (mAP), Practical use case.	10	L3
Module 3		
Generative AI Models Variational Autoencoders and GANs (Variations of GANs), combining VAEs & GANs, Generative Models (Text, Image), Image Captioning, Attention based models (Transformers).	10	L3
Module 4		
Normalizing Flows and Diffusion Models Diffusion process, Forward Diffusion, Reverse Diffusion, Training a diffusion model, Architecture, Guided Diffusion, Stable diffusion, Sampling Procedure,Practical	10	L3

Implementation.		
Module 5		
Face Recognition Deep learning for face recognition: face detection in photographs, face identification & verification using VGGFace2, and face classification using FaceNet. Practical use case. Challenges: privacy and ethical considerations, variability in pose, expression, lightning, and occlusion.	**10**	**L3**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Understand the basic concepts, terminology, theories, models, and methods in the field of computer vision.
CO2	Apply Generative AI for text and image applications.
CO3	Apply diffusion models to understand the working of removal of noise.
CO4	Apply state-of-the-art architectures such as R-CNN and YOLO for object detection.
CO5	Demonstrate the face recognition concepts in detecting the photography, face identification, face classification.

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	2	2	2	3	3	2					3	2	3	
CO2	2	2	2	3	3	2					3	2	3	
CO3	3	2	3	3	3	2			3		3	2	2	
CO4	3	2	3	3	3	2			3		3	2	3	
CO5	3	3	3	3	3	3			3		3	2	2	
Average	3	2	3	3	3	2			3		3	2	3	

High-3: Medium-2: Low-1

Text Books:

1. Deep learning for Computer Vision by Jason Brownlee.

Reference Books:

1. Computer Vision: Algorithms and Applications (Texts in Computer Science) Hardcover – 19 October 2010 by Richard Szeliski (Author)

E-Books / Web References:

1) https://analyticsindiamag.com/optimisation-machine-learning-methods-gradient-descent/
2) https://serokell.io/blog/ml-optimization
3) https://machinelearningmastery.com/why-optimization-is-important-in-machine-learning/

MOOCs:

1. Deep Learning specialization in Coursera.
2. https://nptel.ac.in/courses/106106184
3. https://www.udemy.com/topic/deep-learning/

Scheme of Examination (CIE):

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Typical evaluation pattern for regular courses is shown in Table 1:

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	QUIZ/Assignment	20	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

CLOUD COMPUTING

Semester:	6	CIE Marks	50
Course Code	21AML63	SEE Marks	50
Hours/Week (L: T: P)	3:0:2	Duration of SEE (hours):	03
Type of Course	IPC	Credits	03

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Discuss the concepts, characteristics, delivery models and benefits of cloud computing.
2	Explore the key technical, organizational and compliance challenges of cloud computing.
3	Grasp the concepts of virtualization efficiently.
4	Explore the security issues that arise from cloud computing architectures intended for delivering Cloud based enterprise IT services

Module 1	No. of Hours	RBT Level
Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.	10	L2
Module 2		
Cloud Computing: Application Paradigms.: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Gre The Web application, Cloud for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.	10	L2
Module 3		
Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization, Exercises	10	L3

and problems.		
Module 4		
Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling, Exercises and problems	**10**	**L3**
Module 5		
Cloud Security, Cloud Application Development: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis .Exercises and problems.	**10**	**L3**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Compare the strengths and limitations of cloud computing
CO2	Identify the architecture, infrastructure and delivery models of cloud computing.
CO3	Demonstrate the working of VM and VMM on any cloud platforms(public/private), and run a software service on that.
CO4	Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2		3					1	1	1	1	
CO2	2	2	3		3	1		1		1	1	2	1	
CO3	1	1	1		3			1	3	3		1	1	
CO4	2	2	1		2	1		1	2	1	1	1	1	

High-3: Medium-2: Low-1

Text Book:

1. Cloud Computing:Theory and Practice, Dan C Marinescu Elsevier (MK), 2013.
2. Computing Principles and Paradigms, RajkumarBuyya , James Broberg, Andrzej Goscinsk,i Willey, 2014

PARALLEL AND DISTRIBUTED COMPUTING

Semester:	6	CIE Marks	50
Course Code	21AML641	SEE Marks	50
Hours/Week (L: T: P)	2:2:0	Duration of SEE (hours):	03
Type of Course	PEC	Credits	03

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To introduce the fundamentals of parallel and distributed computing architecturesand paradigms
2	To understand the technologies, system architecture, and communication architecture that propelled the growth of parallel and distributed computing systems
3	To develop and execute basic parallel and distributed application using basic programming models and tools.

Module 1	No. of Hours	RBT Level
Introduction to Parallel Computing: The Idea of Parallelism, Power and potential of parallelism, Examining sequential and parallel programs, Scope and issues of parallel and distributed computing, Goals of parallelism, Parallelism and concurrency using multiple instructions streams. **Parallel Architecture:** Pipeline architecture, Array processor, Multi processor architecture, Systolic architecture, Dataflow architecture, Architectural classification schemes, Memory access classification, **Memory Issues :** Shared vs. distributed, Symmetric multiprocessing (SMP), SIMD, Vector processing, GPU co-processing, Flynn's Taxonomy, Instruction Level support for parallel programming, Multiprocessor caches and Cache Coherence, Non-Uniform Memory Access (NUMA).	08	L2
Module 2		
Parallel Algorithm and Design: Preliminaries – Decomposition Techniques – Characteristics of Tasks and Interactions – Mapping Techniques for Load balancing – Parallel Algorithm Models.	08	L2
Module 3		
Introduction to Distributed Systems: Introduction – Characterization of Distributed Systems – Distributed Shared Memory – Message Passing – Programming Using the Message Passing Paradigm – Group Communication – Case Study (RPC and Java RMI).	08	L2
Module 4		

Reference Books:

1. Cloud Computing Implementation, Management and Security John W Rittinghouse, James F Ransome, CRC Press, 2013.

E-Books / Web References:

1. https://www.javatpoint.com/cloud-computing-tutorial
2. https://www.tutorialspoint.com/cloud_computing/index.htm
3. https://www.digimat.in/nptel/courses/video/106105167/L01.html (Video Lectures)

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Typical evaluation pattern for regular courses is shown in Table 1:

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	QUIZ/Assignment	20	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionatelyreduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module

Coordination: Time and Global States – Synchronizing Physical Clocks – Logical Time and Logical Clock – Coordination and Agreement – Distributed Mutual Exclusion – Election Algorithms – Consensus and Related Problems	08	L3
Module 5		
Distributed Transactions: Transaction and Concurrency Control – Nested Transactions – Locks – Optimistic Concurrency Control – Timestamp Ordering - Distributed Transactions – Flat and Nested – Atomic – Two PhaseCommit Protocol – Concurrency Control. **Distributed System Architecture and its Variants:** Distributed File System: Architecture – Processes – Communication Distributed Web-basedSystem: Architecture – Processes – Communication. Overview of Distributed Computing Platforms.	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Design and implement distributed computing systems and Asses models for distributedsystems.
CO2	Design and implement distributed algorithms.
CO3	Experiment with mechanisms such as client/server and P2P algorithms, remote procedure calls (RPC/RMI), and consistency
CO4	Analyze the requirements for programming parallel systems and critically evaluate the strengths and weaknesses of parallel programming models.
CO5	Analyze the efficiency of a parallel processing system and evaluate the types of applicationfor which parallel programming is useful.

CO/PO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -1	PSO -2
CO1	3	3	0	2	2	2	0	0	0	1	0	3	-	2
CO2	3	3	0	3	3	2	0	0	0	1	0	3	-	2
CO3	3	3	0	3	3	2	0	0	0	1	0	3	-	2
CO4	3	3	0	3	3	2	0	0	0	1	0	3	-	2
CO5	3	3	0	2	2	2	0	0	0	1	0	3	-	2

High-3: Medium-2: Low-1

Text Books:

1. George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair, —Distributed Systems: Concepts and Design, 5th Edition, Pearson / Addison –Wesley, 2012

2. Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar, —Introduction to Parallel

Computing‖, Pearson, 2nd Edition, 2008
3. I.A Dhotre, Parallel and Distributed Computing, 2nd Edition, Technical Publication, 2022

Reference Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, —Distributed Systems: Principles and Paradigms‖, Pearson, 2nd Edition, 2006
2. Pradeep K. Sinha, —Distributed Operating System: Concepts and Design‖, PHILearning Pvt.Ltd., 2007

E-Books / Web References:

1. https://www.geeksforgeeks.org/difference-between-parallel-computing-and-distributed computing/
2. https://www.gacbe.ac.in/pdf/ematerial/18MCS35E-U1.pdf

MOOCs:

1. https://www.mygreatlearning.com/iit-madras-acse?&utm_source=Search
2. https://in.coursera.org/courses?query=parallel%20computing

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Typical evaluation pattern for regular courses is shown in Table 1:

Table 1: CIE Evaluation

Components	Marks	Total
CIE TEST 1	40	50
CIE TEST 2	40	
CIE TEST 3	40	
AAT	10	

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

INTELLIGENT EMBEDDED SYSTEMS

Semester:	6	CIE Marks	50
Course Code	21AML642	SEE Marks	50
Hours/Week (L: T: P)	2:2:0	Duration of SEE (hours):	03
Type of Course	PC	Credits	03

Prerequisites (if any): C and C++ programming languages, RTOS.

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To understand principles and algorithms for prototyping embedded systems with high level of deduction and adaptation.
2	To provide students with holistic view and detailed knowledge of hardware – software co-design of intelligent, real-time embedded systems

Module 1	No. of Hours	RBT Level
Fundamentals of Embedded System: Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power-supply (Battery technology, Solar), PCB and Passive components, Safety and reliability, environmental issues. Ethical practice. Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency	8	L2
Module 2		
Embedded Hardware Design: Introduction to ARM-v7-M (Cortex-M3), ARM-v7-R(CortexR4) and comparison between them. Embedded System Interfacing: Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network	8	L2
Module 3		
Learning in Embedded Systems: Introduction, From Metrology to Digital Data, Uncertainty; Information and Learning Mechanisms, Randomized Algorithms, Robustness Analysis , Embedded C-programming concepts (from embedded system point of view): Optimizing for Speed/Memory needs, Interrupt service routines, macros, functions, modifiers, data types, device drivers, Multithreading programming. Basic embedded C programs/applications for ARM-v7, using ARM-GCC-tool-chain,Emulation of ARM-v7 (e.g. using QEMU), and Linux porting on ARM-v7 (emulation) board	8	L3
Module 4		
Introduction to Embedded Systems in Health Care Domain: Embedded System in Bio-medical applications: Criticality, Reactivity, Autonomy; Trends in medicalsystems: Ambient Intelligence, Assistive technologies for procedures, In-Body devices, Treating	8	L3

Machines, Monitoring/Imaging Systems, VR enhanced Realitysystems		
Module 5		
Embedded Systems and Medical Applications: Managing Chronic conditions, Wellness Management, Clinical Support, Specific Embedded Architectures with grid service architectures, Privacy and Security Issues, Hybrid Electronic and biological systems : Informatics and biologically active – augmentation with genetic data	8	**L3**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Understanding of the fundamental design paradigms, architectures, possibilities andchallenges for embedded systems from both hardware and software perspective.
CO2	Understanding the methodological knowledge of the development of intelligent embedded systems.
CO3	Use of recent methods and tools to carry out intelligent embedded system design in the areas ofhealth care
CO4	Understand principles and algorithms for prototyping embedded systems with high level ofdeduction and adaptation.

CO/PO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -1	PSO -2
CO1	3	3	1									1	3	3
CO2	3	3	1									1	3	3
CO3	3	2	3		3				1	1	2	2	3	3
CO4	3	3	3	3	3				1	1	2	2	3	3

High-3: Medium-2: Low-1

Text Book:

1. Introduction to Embedded Systems, Shibu K. V. TMH Publications, 2009.
2. Embedded System Design –A unified hardware and software introduction, Frank Vahid, Tony D. Givargis, John Wiley Publications, 2000.
3. U-Healthcare Monitoring Systems: Volume 1: Design and Applications, Nilanjan Dey, ISBN-13: 978-0128153703, Academic Press Publication, 2018.

Reference Books:

1. Embedded microcontroller and processor design, Charles Greg Osborn,Pearson Publcation, 2010.
2. Embedded Microcomputer Systems –Real Time Interfacing –Jonathan W. Valvano; Cengage Learning; Third edition, CENGAGE Learning Publication, 2012.

E-Books / Web References:

1. https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs05/
2. https://onlinecourses.nptel.ac.in/noc20_cs14/preview

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	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

ARTIFICIAL INTELLIGENCE IN BLOCK CHAIN

Semester:	6	CIE Marks	50
Course Code	21AML643	SEE Marks	50
Hours/Week (L: T: P)	2:2:0	Duration of SEE (hours):	03
Type of Course	PEC	Credits	03

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To introduce the concept and the basics of blockchain technologies
2	To provide knowledge on various applications of blockchain technologies
3	To discuss and describe the history, technology, and applications of Blockchain

Module 1	No. of Hours	RBT Level
Introduction to Blockchain: Blockchain Introduction, history of blockchain, other technologies spawned from blockchain, mechanism behind blockchain, limitations and challenges of blockchain.	08	L2
Module 2		
Applications of Blockchain: Demystfying the blockchain, uses ofblockchain, new components of blockchain, challenges in the use of blockchain technology, more applications of blockchain technology.	08	L2
Module 3		
Blockchain Consensus: Distributed Consensus: Nakamoto consensus, Proofof Work, Proof of Stake, Proof of Burn, Di_culty Level, Sybil Attack,Energy utilization and alternate	08	L2
Module 4		
Blockchain and cryptocurrency: Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin	08	L3
Module 5		
AI in Blockchain: The Blockchain as a Path to Artificial Intelligence, data collection, cleaning, and processing in AI modelling, Smart Contract Advocates on Behalf of Digital Intelligence, Hyperledger **Blockchain implementation:** Naive Blockchain construction, Memory Hard algorithm - Hashcash implementation **Etherium:** Direct Acyclic Graph, Play with Go-etherium, Smart Contract Construction,Toy application using Blockchain, Mining puzzles	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Describe the concept of blockchain and cryptocurrency, Consensus, AI in Blockchain.
CO2	Summarize challenges and uses of blockchain ledgers, Bitcoin protocols and different Blockchain Consensus and AI modeling.
CO3	Analyze Blockchain Consensus and different Vulnerability, Attacks, Sidechain, Namecoin etc.,
CO4	Design Crypto token and smart path by using AI modeling.
CO5	Implement the blockchain algorithms and etherium Concepts.

CO/PO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -1	PSO -2
CO1	3	3	0	2	2	0	0	0	0	1	0	0	-	2
CO2	3	3	0	3	3	0	0	0	0	1	0	0	-	2
CO3	3	3	0	3	3	0	0	0	0	1	0	0	-	2
CO4	3	3	0	3	3	0	0	0	0	1	0	0	-	2
CO5	3	3	0	2	2	0	0	0	0	1	0	0	-	2
Average	3	3	-	3	3	-	-	-	-	1	-	-	-	2

High-3: Medium-2: Low-1

Text Books:

1. Blockchain for Beginners: The Complete Step by Step Guide to Understanding Blockchain Technology, Mark Watney, 2017
2. Blockchain: Step-By- Step Guide to Understanding and Implementing Blockchain Technology, Paul Laurence, 2018

Reference Books:

1. Ganesh Prasad Kumble , —Hands-On Artificial Intelligence for Blockchain: Converging Blockchain and AI to build smart applications for new economies‖ 2020
2. Kiran Garimella, Peter Fingar, Vint Cerf, —AI + Blockchain‖ 2018
3. Stein Smith, Sean , Blockchain, Artificial Intelligence and Financial Services Implications and Applications for Finance and Accounting Professionals, Springer,2020

E-Books / Web References:

1. https://www.pdfdrive.com/iot-ai-and-blockchain-for-net-e176367528.html
2. https://dl.ebooksworld.ir/motoman/Apress.IoT.AI.and.Blockchain.for.NET.www.EBooksWorld.ir.pdf

Scheme of Examination (CIE):

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CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

SEMESTER – V/VI

Course: Environmental Science

Course Code	21CIV57/67	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	1	Examination Hours	1 hour

Course Learning Objectives:

CLO1	The fundamentals of environmental science.
CLO2	The types of natural resources
CLO3	The various global environmental concerns.
CLO4	The types of wastes generated and their handling at a basic level
CLO5	The area of environmental law and policies with a few important acts in the field

Content	No. of Hours/ RBT Levels
Module 1 **Environment:** • Definition, scope & importance • Components of Environment Ecosystem: Structure and function of various types of ecosystems • Human Activities – Food, Shelter, and Economic & Social Security. • Population - Growth, variation among nations – population explosion and impact on environment **Biodiversity:** Types, Value; Hot spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.	04 Hours / L2
Module 2 **Natural Resources**: Forest, Water, Mineral, Food, Energy, Land Environmental Pollution - Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards.	04 Hours / L2
Module 3 **Global Environmental Concerns** (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.	04 Hours / L2
Module 4 **Sources:** Sources of Solid waste, Types of solid waste, Physical and Chemical composition of municipal solid waste. Solid Waste Management Rules in India Sources and management of E – Waste, Biomedical Waste, Hazardous waste, and construction waste at individual and community level. Socio-economic aspect of waste management Environmental Toxicology.	04 Hours / L2
Module 5 **Latest Developments in Environmental Pollution Mitigation Tools** (Concept and Applications): Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship, NGOs.	04 Hours / L2

COURSE OUTCOMES: Upon completion of this course, student will be able to:

21CIV57.1/67.1	Understand holistically the key concepts "Environment", and "Biodiversity".
21CIV57.2/67.2	Classify the types of natural resources available and the effects of anthropogenic interventions.
21CIV57.3/67.3	Express the gravity of various global environmental concerns.
21CIV57.4/67.4	Categorize the types of wastes generated and their handling at a basic level.
21CIV57.5/67.5	Understand the importance of environmental law and policies.

Textbooks:

1. Environmental studies, Benny Joseph, Tata Mcgraw-Hill 2nd edition 2012
2. Environmental studies, S M Prakash, pristine publishing house, Mangalore 3rd edition-2018
3. Gilbert M.Masters, Introduction to Environmental Engineering and Science, 2nd edition, Pearson Education, 2004

Reference books:

1. Benny Joseph, Environmental studies, Tata Mcgraw-Hill 2nd edition 2009
2. M.Ayi Reddy Textbook of Environmental Science and Technology, BS publications 2007
3. Dr. B.S Chauhan, Environmental Studies, University of science press 1st edition

Web References:

https://www.hzu.edu.in/bed/E%20V%20S.pdf

https://onlinecourses.nptel.ac.in/noc23_hs155/preview

https://onlinecourses.swayam2.ac.in/cec19_bt03/preview

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
	CIE Test-2	**50**	
SEE	Semester End Examination	**50**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
21CIV57.1/67.1	2	-	-	-	-	-	3	-	-	-	-	-	1	-	-
21CIV57.2/67.2	2	1	-	-	-	-	3	-	-	-	-	1	1	-	1
21CIV57.3/67.3	2	-	2	-	-	2	3	1	-	-	-	1	1	-	1
21CIV57.4/67.4	2	2	-	-	-	2	3	-	-	-	-	-	-	-	1
21CIV57.5/67.5	2	-	-	-	-	2	3	-	-	-	-	-	-	1	1
Average	**2**	**1.5**	**2**	**-**	**-**	**2**	**3**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**

Low-1: Medium-2: High-3

VII SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21AML71	Business Intelligence	PC	Respective Department	2	2	0	50	50	100	3
2	21AML72	Natural Language Processing	IPC		3	0	2	50	50	100	4
3	21AML73	Quantum Computing	IPC		3	0	2	50	50	100	4
4		**Program Elective 3**	PEC		2	2	0	50	50	100	3
	21AML741	Datamining and Data warehousing									
	21AML742	Introduction to Robotics									
	21AML743	Human Computer Interaction									
5		**Open Elective 2**	OEC	Offering Department	3	0	0	50	50	100	3
	21AML751	Python Libraries for AI & ML									
	21AML752	Web designing Tools and Frameworks									
6	21AMLP76	Project Phase 1	MP	Two Contact hours per week				100	-	100	2
				TOTAL				**350**	**250**	**600**	**19**

Program Elective 3*			
21AML741	Datamining and Data warehousing	21AML743	Human Computer Interaction
21AML742	Introduction to Robotics		
Open Elective 2 (Offered to other branch students)			
21AML751	Python Libraries for AI & ML		
21AML752	Web designing Tools and Frameworks		

***NPTEL for Credit transfer**: Students can take 12 weeks NPTEL course as an equivalent to Program elective. The NPTEL courses of duration less than 12 weeks will not be considered for credit transfer. The courses (only technical) taken are as per the recommendation of BOS of respective department. The similarity of the contents as offered by NPTEL should not exceed a maximum of 40% of the courses being registered by the student. The NPTEL course need to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not be considered. The validity of NPTEL certificate is for two years and it cannot be used more than once to avail the benefit. The student is eligible to transfer a maximum of nine credits in the entire duration of the program. The grades will be awarded as equivalent to the grades obtained in the NPTEL course.

VIII **SEMESTER**

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1		**Program Elective 4**	PEC		3	0	0	50	50	100	3
	21AML811	High Performance Computing									
	21AML812	Intelligent Embedded System									
	21AML813	Edge AI									
2		**Program Elective 5**	PEC		3	0	0	50	50	100	3
	21AML821	Augment Reality and Virtual Reality									
	21AML822	Predictive Analysis in IoT									
	21AML823	Intelligent Multiagent and Expert System									
3	21AML84	Project work phase – II	MP	Two Contact hours per week				100	100	200	12
4	21AMLS85	Technical Seminar	MP	One Contact hour per week				100	--	100	1
5	21INT85	Internship	INT	Completed during the intervening period of VI and VII Semester				100	--	100	2
				TOTAL				**400**	**200**	**600**	**21**

Program Elective 4*			
21AML811	High Performance Computing	21AML813	Edge AI
21AML812	Intelligent Embedded System		
Program Elective 5*			
21AML821	Augment Reality and Virtual Reality	21AML823	Intelligent Multiagent and Expert System
21AML822	Predictive Analysis in IoT		

***NPTEL for Credit transfer**: Students can take 12 weeks NPTEL course as an equivalent to Program elective. The NPTEL courses of duration less than 12 weeks will not be considered for credit transfer. The courses (only technical) taken are as per the recommendation of BOS of respective department. The similarity of the contents as offered by NPTEL should not exceed a maximum of 40% of the courses being registered by the student. The NPTEL course need to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not be considered. The validity of NPTEL certificate is for two years and it cannot be used more than once to avail the benefit. The student is eligible to transfer a maximum of nine credits in the entire duration of the program. The grades will be awarded as equivalent to the grades obtained in the NPTEL course.

SEMESTER – VII

BUSINESS INTELLIGENCE

Semester:	7	CIE Marks	50
Course Code	21AML71	SEE Marks	50
Hours/Week (L: T: P)	2:2:0	Duration of SEE (hours):	03
Type of Course	PC	Credits	03

Prerequisites (if any): Data Base systems

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Be exposed with the basic rudiments of business intelligence system
2	Understand the modeling aspects behind Business Intelligence
3	Understand of the business intelligence life cycle and the techniques used in it

Module 1	No. of Hours	RBT Level
Business Intelligence: Effective and timely decisions – Data, information and knowledge – Role of mathematical models – Business intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence.	08	L2
Module 2		
Knowledge Delivery: The business intelligence user types, Standard reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, dimensional analysis, Alerts/Notifications, Visualization: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Visualization, Integrated Analytics, Considerations: Optimizingthe Presentation for the Right Message.	08	L2
Module 3		
Efficiency: Efficiency measures – The CCR model: Definition of target objectives- Peer groups – Identification of good operating practices; cross efficiency analysis – virtual inputs and outputs – Other models. Pattern matching – cluster analysis, outlier analysis	08	L2
Module 4		
Business Intelligence Applications: Marketing models – Logistic and Production models – Case studies.	08	L3
Module 5		
Future of Business Intelligence: Future of business intelligence – Emerging Technologies, Machine Learning, Predicting the Future, BI Search & Text Analytics – Advanced Visualization – Rich Report, Futurebeyond Technology.	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Describe the fundamentals of business intelligence, data analysis and knowledge delivery stages.
CO2	Analyze the data analysis and knowledge delivery stages, and Future of Business Intelligence
CO3	Compare efficiency measures with the different techniques and Business Intelligence Applications.
CO4	Apply business intelligence methods to various situations.
CO5	Use the business intelligence knowledge to develop Emerging Technologies and different business applications.

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO -2
CO1	3	2	-	-	-	1	-	1	-	-	-	2	-	2
CO2	3	2	-	-	-	1	-	1	-	-	-	2	-	2
CO3	3	2	-	-	-	1	-	1	-	-	-	2	-	2
CO4	3	2	-	-	3	1	-	1	-	-	-	2	-	2
CO5	3	2	-	-	-	1	-	1	-	-	-	2	-	2

High-3: Medium-2: Low-1

Text Books:

1. "Decision Support and Business Intelligence Systems", Efraim Turban, Ramesh Sharda,Dursun Delen, 9th Edition, Pearson 2013.

Reference Books:

1. "Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making",Larissa T. Moss, S. Atre, Addison Wesley, 2003.
2. "Business Intelligence: Data Mining and Optimization for Decision Making", Carlo Vercellis, Wiley Publications, 2009.
3. "Business Intelligence: The Savvy Manager's Guide", David Loshin Morgan, Kaufman,Second Edition, 2012.
4. "Successful Business Intelligence: Secrets to Making BI a Killer App", Cindi Howson,McGraw- Hill, 2007.
5. "The Data Warehouse Lifecycle Toolkit", Ralph Kimball , Margy Ross, Warren Thornthwaite,Joy Mundy, Bob Becker, Wiley Publication Inc.,2007

E-Books / Web References:

1. https://github.com/topics/business-intelligence
2. https://www.techtarget.com/searchbusinessanalytics/resources/Business-intelligence- technology
3. https://www.pdfdrive.com/business-intelligence-and-analytics-e56416503.html

Scheme of Examination (CIE):

In order to encourage innovative methods while delivering a course, the faculty members have been encouraged to use the **Alternative Assessment Tool (AAT).** The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices.

Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical evaluation pattern for regular courses is shown in Table 1:

	Component	Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

NATURAL LANGUAGE PROCESSING

Semester:	VII	CIE Marks	50
Course Code	21AML72	SEE Marks	50
Hours/Week (L: T: P)	3:0:2	Duration of SEE (hours):	03
Type of Course	IPC	Credits	04

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To Provide a basic understanding of multidimensional techniques for speech representation and classification methods.
2	To Provide a basic understanding of multidimensional techniques for speech representation and classification methods
3	To provide students with a solid grasp of language modeling, classification algorithms, and advanced language processing concepts, fostering proficiency in language model evaluation and sentiment analysis.
4	To provide students with a thorough understanding of speech processing
5	To provide students with expertise in video segmentation and practical applications.

Module 1	No. of Hours	RBT Level
Knowledge in Speech and Language Processing: Overview, Knowledge in Speech and Language Processing, Models and Algorithms, Language, Thought, and Understanding, Real time Examples. R1C1 Natural Language Processing: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages- NLP Applications-Information Retrieval. Language Modelling: Various Grammar- based Language Models-Statistical Language Model. R2C1,2	10	L2
Module 2		
Regular Expressions, Text Normalization, Edit Distance: Regular Expressions: Basic Regular Expression Patterns, Disjunction, Grouping, and Precedence, A Simple Example, More Operators, A More Complex Example, Substitution, Capture Groups, and ELIZA, R1C2 Words and Transducers: Survey of English Morphology, Finite state Morphological parsing, Construction of finite stete lexicon, Finete stete transducer. R1C3	10	L2
Module 3		
N-gram Language Models and classification algorithms: N-Grams, Evaluating Language Models, Sampling sentences from a language model, Generalization and Zeros, Unknown Words, Smoothing, Kneser-Ney Smoothing, R1C4 Parts of Speech tagging: English word classes, Tagsets for English, Parts of speech tagging, Rules based Parts of speech tagging, , HMM Parts of speech tagging	10	L2
Module 4		
Speech Synthesis: Text Normalization, Phonetic analysis, Prosodic analysis, Diphone	10	L2

waveform synthesis, Unit selection synthesis Automatic Speech Recognition: Speech Recognition Architecture, the hidden Markov model apply to speech, Feature extraction, Acoustic likelihood computation, search and decoding		
Module 5		
Speech Recognition, advanced topic: Multipass decoding, A* decoding, Context-dependent acoustic model, Descriminative training, modelling variation, Metada, Speech recognition by humans	**10**	**L2**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	**Explain** the practical aspects of natural language and speech processing.
CO2	**Executing** knowledge about applications of speech processing, including speech enhancement, speaker recognition and speech recognition.
CO3	**Describe** the importance of natural language and analyse the natural language text.
CO4	**Demonstrate** information retrieval techniques

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO -1	PSO -2
CO1	3	3	3	3		1			1			1		
CO2	3	3	3	3	3	1			1			3		
CO3	3	3	3	3		3			3			1		
CO4	3	3	3	3	3	1			2			1		

High-3: Medium-2: Low-1

Texts:

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Prentice Hall, 2008.
2. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.

References:

1. D. O'Shaughnessy, Speech Communications: Human and Machine, 2nd Ed, IEEE Press, 2000. 2. A. Gersho and R. M. Gray, Vector Quantization and Signal Compression, Kluwer Academic, 1991.
2. L. Rabiner and R. W. Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.
3. K. Sayood, Introduction to Data Compression, 2nd Ed, Morgan Kaufmann, 2000.
4. James Allen, "Natural Language Understanding", 2nd edition, Benjamin/Cummings publishing company, 1995.
5. Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems", Kluwer academic Publishers, 2000
6. Anne Kao and Stephen R. Poteet (Eds), "Natural Language Processing and Text Mining", Springer-Verlag London Limited 2007.
7. L. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Prentice Hall, 1993

E-Books / Web References:

1. https://www.ldc.upenn.edu/
2. https://ocw.mit.edu/courses/6-864-advanced-natural-language-processing-fall-2005/pages/lecture-notes/
3. https://www.nltk.org/
4. https://opennlp.apache.org/

Coursera:

1. Natural Language Processing Specialization by University of Michigan: This specialization covers topics in NLP, including sequence models, deep learning, and more.
2. Speech and Audio Processing by Duke University: This course covers the fundamentals of speech and audio signal processing.

Udemy:

1. Natural Language Processing with Python by Udemy: This course focuses on practical NLP applications using Python.
2. Deep Learning for NLP and Speech Recognition by Udemy: This course covers deep learning techniques for NLP and speech recognition.

Scheme of Examination (CIE):

In order to encourage innovative methods while delivering a course, the faculty members have been encouraged to use the **Alternative Assessment Tool (AAT).** The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices.

Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.
Typical evaluation pattern for regular courses is shown in Table 1:

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

QUANTUM COMPUTING

Semester:	**3**	**CIE Marks**	**50**
Course Code	**21AML73**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**3:0:2**	**Duration of SEE (hours):**	**03**
Type of Course	**IPC**	**Credits**	**04**

Prerequisites (if any): Basics of Maths, Calculus, Linear Algebra

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To Analyze the behavior of basic quantum algorithms
2	To Implement simple quantum algorithms and information channels in the quantum circuit model
3	To Prove basic facts about quantum information channels
4.	Simulate a simple quantum error-correcting code

Module 1	No. of Hours	RBT Level
Introduction: Overview, Computers and the Strong Church–Turing Thesis, The Circuit Model of Computation, A Linear Algebra Formulation of the Circuit Model, Reversible Computation, A Preview of Quantum Physics, Quantum Physics and Computation	10	L2
Module 2		
Qubits And The Framework Of Quantum Mechanics: The State of a Quantum System, Time-Evolution of a Closed System, Composite Systems, Measurement, Mixed States and General Quantum Operations	10	L2
Module 3		
A Quantum Model Of Computation: The Quantum Circuit Model, Quantum Gates, 1-Qubit Gates, Controlled-U Gates, Universal Sets of Quantum Gates, Efficiency of Approximating Unitary Transformations, Implementing Measurements with Quantum Circuits.	10	L3
Module 4		
Superdense Coding And Quantum Teleportation: Superdense Coding, Quantum Teleportation, An Application of Quantum Teleportation Introductory Quantum Algorithms: Probabilistic Versus Quantum Algorithms, Phase Kick-Back, The Deutsch Algorithm, The Deutsch–Jozsa Algorithm, Simon's Algorithm.	10	L3
Module 5		
Algorithms With Superpolynomial Speed-Up: Quantum Phase Estimation and the Quantum Fourier Transform, Error Analysis for Estimating Arbitrary Phases, Periodic States, LCM, the Extended Euclidean Algorithm, Eigenvalue Estimation, TEAM LinG, Finding-Orders, The Order-Finding Problem, Some Mathematical Preliminaries, The Eigenvalue Estimation Approach to Order Finding, Shor's Approach to Order Finding	10	L3

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1	Describe the behavior of basic quantum algorithms concepts.
CO2	Gather and Analyze different quantum operations.
CO3	Analyze Superdense Coding And Quantum Teleportation, Quantum Gates etc.,
CO4	Design a suitable Quantum Gates and Implementing Measurements with Quantum Circuits.
CO5	Apply Quantum Circuit Model, Algorithms With Super Polynomial Speed-Up, Reversible Computation.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO 12	PSO 1	PSO 2
CO1	3	2	1	1	1	1					1		1	2
CO2	2	3	1	1	1	2					1		1	2
CO3	2	2	3	2	1	1					1		1	2
CO4	2	1	2	1	1	1					2		1	2
CO5	2	2	2	1	2	1					3		1	2

High-3: Medium-2: Low-1

Text Book:

1. Phillip Kaye, Raymond Laflamme, Michele Mosca: An Introduction to Quantum Computing, Oxford University Press, 2007.

Reference Books:

1. M. A. Nielsen and I. L. Chuang. Quantum Computation and Quantum Informatio, Cambridge University Press, 2000.
2. Peres, Asher. Quantum Theory: Concepts and Methods. New York, NY: Springer, 1993. ISBN: 9780792325499.

E-Books / Web References:

1) Preskill, J. Notes on Quantum Computation.

Scheme of Examination (CIE):

In order to encourage innovative methods while delivering a course, the faculty members have been encouraged to use the Alternative Assessment Tool (AAT). The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices.

Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical evaluation pattern for regular courses is shown in Table 1:

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	QUIZ/Assignment	20	
SEE	Semester End Examination	100	50
		Grand Total	100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

DATA MINING & DATA WAREHOUSING

Semester:	VII	CIE Marks	50
Course Code	21AML741	SEE Marks	50
Hours/Week (L: T: P)	2:2:0	Duration of SEE (hours):	03
Type of Course	PEC	Credits	03

Prerequisites (if any): NIL

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Introduction to general issues of Data Warehouse and Data Mining.
2	Understanding of the different architectures and mining techniques
3	The role and functions of Data Warehouse and Data Mining
4	Explain the stages and process different data mining techniques
5	Learn mining and warehouse techniques through the use of different tools

Module 1	No. of Hours	RBT Level
Data Warehousing & modeling: Basic Concepts: Data Warehousing: A multitier Architecture, Data warehouse models: Enterprise warehouse, Data mart and virtual warehouse, Extraction, Transformation and loading, Data Cube: A multidimensional data model, Stars, Snowflakes and Fact constellations: Schemasfor multidimensional Data models, Dimensions: The role of concept Hierarchies, Measures: Their Categorization and computation, Typical OLAP Operations.	08	L2
Module 2		
Data warehouse implementation & Data mining: Efficient Data Cube computation: An overview, Indexing OLAP Data: Bitmap index and join index, Efficient processing of OLAP Queries, OLAP server Architecture ROLAP versus MOLAP Versus HOLAP.: Introduction: What is data mining, Challenges, Data Mining Tasks, Data: Types of Data, Data Quality, Data Preprocessing, Measures ofSimilarity and Dissimilarity,	08	L2
Module 3		
Association Analysis: Association Analysis: Problem Definition, Frequent Item set Generation, Rule generation. Alternative Methods for Generating Frequent Itemsets, FP-Growth Algorithm, Evaluation of Association Patterns.	08	L2
Module 4		
Classification: Decision Trees Induction, Method for Comparing Classifiers, Rule Based Classifiers, Nearest Neighbor Classifiers, Bayesian Classifiers	08	L3
Module 5		
Clustering Analysis: Overview, K-Means, Agglomerative Hierarchical Clustering, DBSCAN, Cluster Evaluation, Density-Based Clustering, Graph Based Clustering, Scalable Clustering Algorithms	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Explain the basic concepts of data warehousing, architecture and data warehousing models.
CO2	Understand data mining problems and implement the data warehouse.
CO3	Illustrate the various data pre-processing Methods.
CO4	Demonstrate the association rules for a given data pattern
CO5	Analyze classification and prediction of data.

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	3	3	3	3	3	1	2	2	1	2	2	3	1	2
CO2	3	3	3	3	3	1	1	1	1	2	1	3	1	2
CO3	3	3	3	3	3	3	1	1	3	2	1	3	1	2

High-3: Medium-2: Low-1

Text Books:

1. Pang-Ning Tan, Michael Steinbach, Vipin Kumar: Introduction to Data Mining, Pearson, First impression,2014.

2. Jiawei Han, Micheline Kamber, Jian Pei: Data Mining -Concepts and Techniques, 3rd Edition, Morgan Kaufmann Publisher, 2012

References:

1. Sam Anahory, Dennis Murray: Data Warehousing in the Real World, Pearson, Tenth Impression,2012.
2. Michael. J. Berry, Gordon. S. Linoff: Mastering Data Mining, Wiley Edition, second edtion,2012.

E-Books / Web References:

1. https://nptel.ac.in/courses/106/106/106106093/
2. https://nptel.ac.in/courses/110/107/110107092/
3. https://nptel.ac.in/courses/106/105/106105174/
4. VTU e-Shikshana Program 5. VTU EDUSATProgram

MOOCs:

1. https://www.udemy.com/course/data-warehouse-fundamentals-for-beginners/
2. https://www.udemy.com/course/data-warehouse-the-ultimate-guide/
3. https://www.udemy.com/course/data-mining-fundamentals-for-beginners/
4. https://onlinecourses.nptel.ac.in/noc21_cs06/preview

Scheme of Examination (CIE):

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Typical evaluation pattern for regular courses is shown in Table 1:

	Component	Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

INTRODUCTION TO ROBOTICS

Semester:	**VII**	**CIE Marks**	**50**
Course Code	**21AML742**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites (if any): Sound knowledge of basic mathematics concepts to implement in software. Statistics, linear algebra, matrix, calculus, probability, programming languages and data modelling.

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Fundamental concept of Robotics, Robotic sensors.
2	Concept of AI programming languages.
3	Applications of AI in the field of Robotics.

Module 1	No. of Hours	RBT Level
Fundamentals of Robotics: Basic Concepts: Definition and historical development of robotics – different types and classification of of robots – various generations of robots – Definition of Industrial Robot, degrees of freedom – Asimov's laws of robotics – dynamic stabilization of robots.	08	L2
Module 2		
Robot Kinematics and Sensors: Robot Kinematics: Position Analysis, Dynamic Analysis and Forces, Robot configurations, Robot Components, Robot Degrees of Freedom, Work volume and work envelope, Robot Joints and symbols, Robot Coordinates, Robot Reference Frames, Resolution, accuracy and precision ofRobot, Work cell control **Robotic Sensors:** Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors- Proximity Sensors, Photo Electric Sensors, Position sensors – Piezo Electric Sensor, LVDT, Resolvers, Encoders, Touch Sensors, Safety Sensor: Light Curtain, Laser Area Scanner, Safety Switches,Machine vision too much content in the same module	08	L3
Module 3		
Robot Programming languages & systems: Introduction to Robot Programming, requirements of a robot programming language, Robot software functions - coordinate systems, position control, other control functions, subroutines, problems	08	L3

peculiar to robot programming languages, Program planning for Robot flowcharting for robot programs with few examples.		
Module 4		
Introduction to Robotic Process Automation: RPA Platforms: Components of RPA-RPA Platforms-About Ui Path- About UiPath - The future of automation - Record and Play - Downloading and installing UiPath Studio -Learning Ui Path Studio- - Task recorder - Step-by step examples using the recorder.	08	L3
Module 5		
RPA Sequence, Flowchart, and Control Flow: Sequencing the workflow Activities-Control flow, various types of loops, and decision-making Step-by-stepexample using Sequence and Flowchart-Step-by-step example using Sequence andControl Flow-Data Manipulation-Variables and Scope Collections-Arguments – Purpose and use-Data table usage with examples Clipboard Management-File operation with step-by-step example-CSV/Excel to data table and vice versa (witha step-by-step example).	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Describe Robotics, automation, robotics motion, sensors and control, machinevision, robotic programming and roles of robots in industry.
CO2	Understand the working methodology of robotics and automation, motion and control, machine vision and programming, application of robots in industry.
CO3	Understand the basic concept of RPA and describe various components & platforms of RPA.
CO4	Apply working principles of programming for various applications.
CO5	Write the program for robot for various applications.

	PO -1	**PO -2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO -7**	**PO -8**	**PO -9**	**PO -10**	**PO -11**	**PO -12**	**PSO -1**	**PSO -2**
CO1	3	1	1	1	0							1	1	3
CO2	3	1	1	1	1							1	3	3
CO3	3	1	2	2	3							1	3	3
CO4	3	3	3	3	3				1	1	2	2	3	3
CO5	3	3	3	3	3				1	1	2	2	3	3

High-3: Medium-2: Low-1

Text Books:

1. John J. Craig, "Introduction to Robotics", Addison Wesley publication
2. Dilip Kumar Pratihar, "Fundamentals of Robotics", Narosa Publishing House, (2019)3.
3. Tom Taulli, "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems",2020, ISBN-13 (electronic): 978-1-4842-5729-6, Publisher: A press
4. Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing Release Date: March 2018 ISBN: 9781788470940

Reference Books

1. Srikanth Merianda, "Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation"
2. Mikell P Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, "Industrial Robotics Technology, Programming and Applications", Mc. Graw Hill Book Company, 1986
3. https://www.uipath.com/rpa/robotic-process-automation
4. Introduction to Robotics Mc Kerrow P.J Addison Wesley, USA 1991

E-Books / Web References:

1. https://onlinecourses.nptel.ac.in/noc20_de11/preview
2. https://Introduction-Robotics-eBook-Global-Craig-ebook/dp/B09839HBK4

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SEE	Semester End Examination	100	50
	Grand Total		100

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HUMAN COMPUTER INTERACTION

Semester:	**VII**	**CIE Marks**	**50**
Course Code	**21AML743**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To stress the importance of a good interface design.
2	To understand the importance of human psychology in designing good interfaces.
3	To evaluate applications of human machine interaction ensemble methods in the gaming domains modeling into a cohesive, interactive game application.

Module 1	No. of Hours	RBT Level
HCI Foundation: Input–output channels, Human memory, Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems, Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction.	**08**	**L2**
Module 2		
Designing Interaction: Shneideman's eight golden rules, Norman's Seven principles, Screen Design - Visual Display Layout, Information Structuring and Navigation, HCI in Software process, Design Rules, HCI for Users with Disability, Mobile devices, Earcon design for aural interface.	**08**	**L2**
Module 3		
Interaction Design Models: Model Human Processor - Working Memory, Long-Term Memory, Processor Timing, Keyboard Level Model - Operators, Encoding Methods, Heuristics for M Operator Placement, What the Keyboard Level Model Does Not Model, Application of the Keyboard Level Model, GOMS - CMNGOMS Analysis, Modeling Structure, State Transition Networks	**08**	**L2**
Module 4		
Visual Interface, Emotion in HCI, knowledge driven in HCI, Multi-user Interaction, Interface Selection Options, Wire-Framing. **Applying HCI in Game design:** Introduction to game development life cycle, Key issues of HCI in gaming, Game interface design goal, Basic design principles, method of presenting game user interface, Game design documents and storyboarding,	**08**	**L3**
Module 5		
Clustering Analysis: Overview, K-Means, Agglomerative Hierarchical Clustering, DBSCAN, Cluster Evaluation, Density-Based Clustering, GraphBased Clustering, Scalable Clustering Algorithms **Game Design:** Augmented and Virtual Reality, Anthropology of games, Genres in video game, principle of game design, the Game designer usability and gameplay	**08**	**L2**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	**Explain** basic concepts like Human memory, thinking: reasoning and problem solving etc.,
CO2	**Analyze** and **interpret** data, Psychology and the design of interactive systems, Clustering Analysis.
CO3	**Determine** the usage of HCI methods in gaming, Game design documents and storyboarding
CO4	**Design** Game interface, Game with Augmented and Virtual Reality, Anthropology of games etc.,
CO5	**Apply** Clustering Algorithms for different applications

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	3					2		2		1		3		
CO2		3				2	2			1		3		
CO3				3	3	2		2		1		3		
CO4			3			2	2			1		3		
CO5			3			2		2		1		3		

High-3: Medium-2: Low-1

Texts:

1. Gerard Jounghyun Kim, Human Computer Interaction – Fundamentals and Practice, – CRC press, 2015.
2. Regina Bernhaupt , Game User Experience Evaluation-2015 Edition, Kindle Edition
3 Martin Helander, Handbook of Human-Computer Interaction-1988 Elsevier

References:

1 Julie A. Jacko, The Human–Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications, 3rd Edition, CRC Press (Taylor & Francis Group) 2012.
2 Ben Shneiderman, Catherine Plaisant, Maxine Cohen,Steven Jacobs, Designing the User Interface: Strategies for Effective Human Computer Interaction, 5th Edition, Pearson, 2009.
3 Alan Dix, Janet E. Finlay, Gregory D. Abowd, Russell Beale, Human - Computer Interactio3rd Edition, Pearson, 2003.
4 The Encyclopedia of Human-Computer Interaction, 2nd Ed. interaction Design Foundation
5 Myounghoon Jeon ,Emotions and Affect in Human actors and Human–Computer Interaction, 2017Academic Press
6 Kevin mullet, Darvel sano,Designing Visual Interfaces: Communication Oriented Techniques,Englewood Cliffs, NJ : SunSoft Press

Scheme of Examination (CIE):

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CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

SEMESTER – VIII

HIGH PERFORMANCE COMPUTING

Semester:	**8**	**CIE Marks**	**50**
Course Code	**21AML811**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**Duration of SEE (hours):**	**3hrs**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Introduce students the design, analysis, and implementation, of high-performance computational science and engineering applications
2	Illustrate on advanced computer architectures, parallel algorithms, parallel languages
3	Illustrate performance-oriented computing.

Module 1	No. of Hours	RBT Level
Introduction to Parallel Computing: Motivating Parallelism, Scope of Parallel Computing, Parallel Programming Platforms: Implicit Parallelism: Trends in Microprocessor Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Routing Mechanisms for Interconnection Networks, Impact of Process-Processor Mapping and Mapping Techniques.	08	L2
Module 2		
Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques forLoad Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models. Basic Communication Operations: One-to-All Broadcast and All-to-One Reduction, Allto-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations	08	L2
Module 3		
Analytical Modeling of Parallel Programs: Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, The Effect of Granularity on Performance, Scalability of Parallel Systems. Minimum Execution Time	08	L2

and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of ParallelPrograms. **Programming Using the Message-Passing Paradigm:** Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topologies and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators		
Module 4		
Programming Shared Address Space Platforms: Thread Basics, Why Threads?, The POSIX Thread API, Thread Basics: Creation and Termination, Synchronization Primitives in Pthreads, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, Tips for Designing Asynchronous Programs **OpenMP:** a Standard for Directive Based Parallel Programming Dense MatrixAlgorithms: Matrix-Vector Multiplication, Matrix-Matrix Multiplication,Solving a System of Linear Equations Sorting: Issues in Sorting on Parallel Computers, Sorting Networks, Bubble Sort and its Variants, Quicksort, Bucket and Sample Sort.	08	L3
Module 5		
Graph Algorithms: Definitions and Representation, Minimum Spanning Tree: Prim's Algorithm, Single-Source Shortest Paths: Dijkstra's Algorithm, All-Pairs Shortest Paths, Transitive Closure, Connected Components, Algorithms for Sparse Graphs, Search Algorithms for Discrete Optimization Problems: Definitions and Examples, Sequential Search Algorithms, Search Overhead Factor, Parallel Depth-First Search, Parallel Best-First Search,Speedup, Anomalies in Parallel Search Algorithms	08	L3

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1	**Describe** the key factors affecting the performance of CSE applications, Principles of Parallel Algorithm Design, Programming Shared Address Space Platforms etc.,
CO2	**Analyze** mapping of applications to high-performance computing systems, and different Graph algorithms.
CO3	**Design** hardware/software co-design for achieving performance on real-world applications
CO4	**Use** Thread Basics and use open MP for Parallel Programming, Message Passing Interface, Topologies and Embedding concepts.
CO5	**Implement** Graph algorithms for Optimization Problems

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	3	3	0	2	2	0	0	0	0	1	0	3	0	2
CO2	3	3	0	3	3	0	0	0	0	1	0	3	0	2
CO3	3	3	0	3	3	0	0	0	0	1	0	3	0	2
CO4	3	3	0	3	3	0	0	0	0	1	0	3	0	2
CO5	3	3	0	2	2	0	0	0	0	1	0	3	0	2

High-3: Medium-2: Low-1

Text Books:

1. Introduction to Parallel Computing, AnanthGrama, Anshul Gupta, George Karypis, and Vipin Kumar, 2nd edition, Addison-Welsey, 2003.

Reference Books:

1. Grama, A. Gupta, G. Karypis, V. Kumar, An Introduction to Parallel Computing, Design and Analysis of Algorithms: 2/e, Addison-Wesley, 2003.
2. G.E. Karniadakis, R.M. Kirby II, Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their Implementation, Cambridge University Press,2003.
3. Wilkinson and M. Allen, Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, 2/E, Prentice Hall, 2005.
4. M.J. Quinn, Parallel Programming in C with MPI and OpenMP, McGraw-Hill, 2004.
5. G.S. Almasi and A. Gottlieb, Highly Parallel Computing, 2/E, Addison-Wesley, 1994.
6. David Culler Jaswinder Pal Singh,"Parallel Computer Architecture: A hardware and Software

E-Books / Web References:

1. https://freecomputerbooks.com/High-Performance-Computing.html
2. https://www.pdfdrive.com/the-art-of-high-performance-computing-for-computational-science-vol-1 techniques-of-speedup-and-parallelization-for-general-purposes- e191494311.html

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	Component	Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

INTELLIGENT EMBEDDED SYSTEMS

Semester:	**8**	**CIE Marks**	**50**
Course Code	**21AML812**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites (if any): C and C++ programming languages, RTOS.

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To understand principles and algorithms for prototyping embedded systems with high level of deduction and adaptation.
2	To provide students with holistic view and detailed knowledge of hardware – software co-design of intelligent, real-time embedded systems

Module 1	No. of Hours	RBT Level
Fundamentals of Embedded System: Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power-supply (Battery technology, Solar), PCB and Passive components, Safety and reliability, environmental issues. Ethical practice. Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency	8	**L2**
Module 2		
Embedded Hardware Design: Introduction to ARM-v7-M (Cortex-M3), ARM-v7-R(CortexR4) and comparison between them. Embedded System Interfacing: Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network	8	**L2**
Module 3		
Learning in Embedded Systems: Introduction, From Metrology to Digital Data, Uncertainty; Information and Learning Mechanisms, Randomized Algorithms, Robustness Analysis , Embedded C-programming concepts (from embedded system point of view): Optimizing for Speed/Memory needs, Interrupt service routines, macros, functions, modifiers, data types, device drivers, Multithreading programming. Basic embedded C programs/applications for ARM-v7, using ARM-GCC-tool-chain, Emulation of ARM-v7 (e.g. using QEMU), and Linux porting on ARM-v7 (emulation) board	8	**L3**
Module 4		
Introduction to Embedded Systems in Health Care Domain: Embedded System in Bio-medical applications: Criticality, Reactivity, Autonomy; Trends in medical systems: Ambient Intelligence, Assistive technologies for procedures, In-Body	8	**L3**

devices, Treating Machines, Monitoring/Imaging Systems, VR enhanced Reality systems		
Module 5		
Embedded Systems and Medical Applications: Managing Chronic conditions, Wellness Management, Clinical Support, Specific Embedded Architectures with grid service architectures, Privacy and Security Issues, Hybrid Electronic and biological systems : Informatics and biologically active – augmentation with genetic data	8	**L3**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Understanding of the fundamental design paradigms, architectures, possibilities andchallenges for embedded systems from both hardware and software perspective.
CO2	Understanding the methodological knowledge of the development of intelligent embedded systems.
CO3	Use of recent methods and tools to carry out intelligent embedded system design in the areas ofhealth care
CO4	Understand principles and algorithms for prototyping embedded systems with high level ofdeduction and adaptation.

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO -2	PSO-3
CO1	3	3	1									1	3	3	1
CO2	3	3	1									1	3	3	1
CO3	3	2	3		3				1	1	2	2	3	3	3
CO4	3	3	3	3	3				1	1	2	2	3	3	3
Average	3	3	2	1	1	-	-	-	0.4	0.4	0.8	1.4	3	3	2

High-3: Medium-2: Low-1

Text Book:

1. Introduction to Embedded Systems, Shibu K. V. TMH Publications, 2009.
2. Embedded System Design –A unified hardware and software introduction, Frank Vahid, Tony D.Givargis, John Wiley Publications, 2000.
3. U-Healthcare Monitoring Systems: Volume 1: Design and Applications, Nilanjan Dey, ISBN-13:978-0128153703, Academic Press Publication, 2018.

Reference Books:

1. Embedded microcontroller and processor design, Charles Greg Osborn,Pearson Publcation, 2010.
2. Embedded Microcomputer Systems –Real Time Interfacing –Jonathan W. Valvano; Cengage Learning; Third edition, CENGAGE Learning Publication, 2012.

E-Books / Web References:

1. https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs05/
2. https://onlinecourses.nptel.ac.in/noc20_cs14/preview

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	Grand Total		100

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Edge AI

Semester:	8	CIE Marks	50
Course Code	21AIML813	SEE Marks	50
Hours/Week (L: T: P)	3:0:0	Duration of SEE (hours):	03
Type of Course	PEC	Credits	03

Prerequisites (if any): Basics of Maths, Calculus, Linear Algebra

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To introduce Edge Computing , Artificial Intelligence Applications on Edge etc.,
2	To illustrate Artificial Intelligence Training at Edge.
3	To provide detail description on Artificial Intelligence for Optimizing Edge

Module 1	No. of Hours	RBT Level
Introduction: A Brief Introduction to Edge Computing, Trends in Edge Computing, Industrial Applications of Edge Computing, Intelligent Edge and Edge Intelligence . **Fundamentals of Edge Computing**, Paradigms of Edge Computing, Cloudlet and Micro Data Centers, Fog Computing, Mobile and Multi-Access Edge Computing (MEC), Definition of Edge Computing Terminologies, Collaborative End–Edge–Cloud Computing, Hardware for Edge Computing, AI Hardware for Edge Computing, Integrated Commodities Potentially for Edge Nodes, Edge Computing Framework, Virtualizing the Edge, Virtualization Techniques, Network Virtualization, Network Slicing, Value Scenarios for Edge Computing, Smart Parks, Video Surveillance, Industrial Internet of Things.	8	L2
Module 2		
Artificial Intelligence Applications on Edge: Real-time Video Analytic, Machine Learning Solution, Deep Learning Solution , Autonomous Internet of Vehicles (IoVs) , Machine Learning Solution , Deep Learning Solution , Intelligent Manufacturing , Machine Learning Solution , Deep Learning Solution , Smart Home and City , Machine Learning Solution , Deep Learning Solution	8	L2
Module 3		
Artificial Intelligence Inference in Edge: Optimization of AI Models in Edge, General Methods for Model Optimization, Model Optimization for Edge Devices , Segmentation of AI Models, Early Exit of Inference (EEoI) , Sharing of AI Computation, **Artificial Intelligence Training at Edge:** Distributed Training at Edge, Vanilla Federated Learning at Edge, Communication-Efficient FL, Contents xiii 6.4 Resource-Optimized FL, Security-Enhanced FL , A Case Study for Training DRL at Edge, Multi-User Edge Computing Scenario, System Formulation, Offloading Strategy for Computing Tasks Based on DRL , Distributed Cooperative Training	8	L3

Module 4		
Edge Computing for Artificial Intelligence: Edge Hardware for AI , Mobile CPUs and GPUs , FPGA-Based Solutions , TPU-Based Solutions , Edge Data Analysis for Edge AI , Challenge and Needs for Edge Data Process, Combination of Big Data and Edge Data Process , Architecture for Edge Data Process , Communication and Computation Modes for Edge AI , Integral Offloading , Partial Offloading, Vertical Collaboration , Horizontal Collaboration , Tailoring Edge Frameworks for AI , Performance Evaluation for Edge AI.	8	**L3**
Module 5		
Artificial Intelligence for Optimizing Edge : AI for Adaptive Edge Caching , Use Cases of DNNs , Use Cases of DRL , AI for Optimizing Edge Task Offloading, Use Cases of DNNs , Use Cases of DRL , AI for Edge Management and Maintenance, Edge Communication , Edge Security , Joint Edge Optimization, A Practical Case for Adaptive Edge Caching, Multi-BS Edge Caching Scenario, System Formulation , Weighted Distributed DQN Training and Cache Replacement	8	**L3**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	**Describe** the Trends in Edge Computing, Mobile and Multi-Access Edge Computing, AI for Adaptive Edge Caching etc.,
CO2	**Analyze** Paradigms of Edge Computing, Artificial Intelligence Inference in Edge.
CO3	**Show** Edge Security , Joint Edge Optimization, A Practical Case for Adaptive Edge Caching
CO4	**Use** Artificial Intelligence for Optimizing Edge, AI for Edge Management and Maintenance .
CO5	**Apply** Vertical Collaboration , Horizontal Collaboration , Tailoring Edge Frameworks for AI.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	2	1	1	1	1					1		1	2
CO2	2	3	1	1	1	2					1		1	2
CO3	2	2	3	2	1	1					1		1	2
CO4	2	1	2	1	1	1					2		1	2
CO5	2	2	2	1	2	1					3		1	2

High-3: Medium-2: Low-1

Text Book:

1. Edge AI Convergence of Edge Computing and Artificial Intelligence by Xiaofei Wang, Yiwen Han , Victor C. M. Leung et al. publisher: Springer, 2020.

Reference Books:

1. Mobile Edge Artificial Intelligence, by Yuanming Shi, Kai Yang, Zhanpeng Yang and Yong Zhou .

2. AI, Edge and IoT-based Smart Agriculture, by Ajith Abraham, Sujata Dash, Joel J.P.C. Rodrigues, Biswaranjan Acharya and Subhendu Kumar Pani

Scheme of Examination (CIE):

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Typical evaluation pattern for regular courses is shown in Table 1:

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

AUGMENT REALITY AND VIRTUAL REALITY

Semester:	**8**	**CIE Marks**	**50**
Course Code	**21AML821**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	To introduce the fundamentals of virtual reality systems, including geometric modelling, transformations, graphical rendering, optics, and human vision.
2	To build a personal VR or AR application for their portfolio
3	To develop Virtual and Augmented Reality industry committed innovative technologies that can be used in the development and production of immersive environments in the fields of entertainment, education, training, medical and industrial innovation.

Module 1	No. of Hours	RBT Level
Design and Art Across Digital Realities: Introduction – How human interacts with computers – Modalities through Ages – New Modalities – Types – Note on Hand Tracking and Hand Pose Recognition – Voice, Hands and HardwareInputs over Next Generation – Sensory Design – Sensory Principles **Introduction to Virtual Reality**: A Brief History of Virtual Reality - The five Classic Components of a VR System - Reality, Virtuality and Immersion - Virtual Reality for Art – VR for Animation – 3D Art Optimization – Ideal Solution – Topology – Baking – Draw Calls – VR Tools to Create 3D Art – Acquiring 3D models – Creating 3D models.	08	L2
Module 2		
Motion tracking, navigation and controllers in VR: Position and Motion Trackers - Magnetic, Mechanical and Ultrasonic Trackers - Navigation and Manipulation Interfaces - Three-Dimensional Probes and Controllers - Data Gloves and Gesture Interfaces - Human Perception and Cognition – Visual System – Auditory System – Physiology, Psychology and Human experience - Effects of VR Simulations on Users - Cyber-sickness, before and now -	08	L2

Guidelines for Proper VR Usage - User Centered Design, User Experience and an Ethical Code of Conduct		
Module 3		
Introduction to Augmented Reality: History of AR – Selection of AR Platform– Integrating Hardware and Software – Optical & Inertial Calibration –Tracking – AR Computer Vision – Mapping – Platforms – Lightings. **Creating Cross-Platform Augmented Reality and Virtual Reality:** Cross Platform Game Engines – Understanding 3D graphics – Virtual Camera – Degree of Freedom – Virtual Reality Toolkit – Best Practices	08	L2
Module 4		
Three Virtual Reality and Augmented Reality Development Best Practices: Developing for Virtual Reality and Augmented Reality Is Difficult - Handling Locomotion- Locomotion in VR and AR – Audio in VR & AR –Inventory for VR – Augmented Reality Raycasts	08	L3
Module 5		
Present and the Future of VR/AR: Immersive reality application areas - Entertainment, Education, Training, Medical, Industrial, Military - Sensing to Rendering - VR, Immersive Tech and the Society - Impact on Professional Life – Personal Life – Public life.	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Understand and develop framework for evaluating current and emerging immersive reality technologies and applications
CO2	Understand the input, output devices, immersive surround sound, haptic and vibrotactile devices
CO3	Understand architecture and integrative immersive media platforms and VR programming
CO4	Analyze the best practices in VR, AR including design,
CO5	Analyze prototyping and ethical code of conduct

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	3	3	0	2	2	0	0	0	0	1	0	3	-	2
CO2	3	3	0	3	3	0	0	0	0	1	0	3	-	2
CO3	3	3	0	3	3	0	0	0	0	1	0	3	-	2
CO4	3	3	0	3	3	0	0	0	0	1	0	3	-	2
CO5	3	3	0	2	2	0	0	0	0	1	0	3	-	2

High-3: Medium-2: Low-

Text Books:

1. Kelly S. Hale (Editor), Kay M. Stanney (Editor). 2014. Handbook of Virtual Environments: Design, Implementation, and Applications, Second Edition (Human Factors and Ergonomics) ISBN-13: 978-1466511842
2. Erin Pangilinan, Steve Lukas and Vasanth Mohan, —Creating Augmented and Virtual Realities Theory & Practice for Next-Generation Spatial Computing‖, O'REILLY 2019
3. Alan B Craig, William R Sherman and Jeffrey D Will, —Developing Virtual Reality Applications: Foundations of Effective Design‖, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, —Designing Virtual Systems: The Structured Approach‖, 2005
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, —3D User Interfaces, Theory and Practice‖, Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, —Spatial Augmented Reality: Meging Real and Virtual Worlds‖, 2005.
4. Tony Parisi. 2015. Learning Virtual Reality ISBN: 9781491922828
5. Michael Madary and Thomas K. Metzinger. 2016. Real Virtuality: A Code of Ethical Conduct. Recommendations for Good Scientific Practice and the Consumers of VR- Technology. Frontiers in Robotics and AI 3, February: 1–23. http://doi.org/10.3389/frobt.2016.00003
6. Jason Jerald. 2015. The VR Book: Human-Centered Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool Publishers

E-Books / Web References:

1. https://www.oreilly.com/library/view/creating-augmented-and/9781492044185/

MOOCs:

1. https://www.infivr.com/?gclid=CjwKCAiA2fmdBhBpEiwA4CcHzVFsS1EGag9py8rG_AUcVElTIZ0czGXDVZPRIn7TE_AY9FlgitZulxoCYhYQAvD_BwE
2. https://www.udemy.com/course/develop-augmented-reality-book-ar-business-card-with-unity

Scheme of Examination (CIE):

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Typical evaluation pattern for regular courses is shown in Table 1:

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module.

PREDICTIVE ANALYSIS AND IOT

Semester:	**8**	**CIE Marks**	**50**
Course Code	**21AML822**	**SEE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**Duration of SEE (hours):**	**03**
Type of Course	**PEC**	**Credits**	**03**

Prerequisites (if any): Basics of Maths, Calculus, Linear Algebra

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	This course will introduce predictive analytics using IoT sensor data.
2	To understand how predictive analytics can be applied in different domains.
3.	To understand applications of Industrial IOT.
4	To develop IoT sensor data for anomaly detection, equipment analysis, health app development using ML, and voltage irregularity identification in household devices.

Module 1	No. of Hours	RBT Level
Principles and Foundations of IOT and AI : IOT reference model – IOT platforms – IOT verticals – Big data and IOT- Infusion of AI, Data Science in IOT – cross - industry standard for data mining – AI and IOT platforms **(Chapter 1) Data Access and Distributed Processing for IOT:** Data formats: TXT, CSV, XLSX, JSON, HDF5, SQL, NO Sql, HDFS data formats – Spark ML for IoT data **(Chapter 2)**	8	**L2**
Module 2		
Personal IOT : Personal IOT – super shoes by MIT – Continuous glucose monitoring – Hypoglycemia prediction using CGM data – Heart Monitor – Digital assistants **(Chapter 9)**	8	**L3**
Module 3		
Home IOT: IOT and smart homes – Human activity recognition – HAR using wearable sensors – HAR from videos – smart lighting – Home surveillance **(Chapter 9)** **AI for smart Cities IoT :** Smart Cities – smart traffic management – parking – waste management – Policing – lighting governance – Challenges and benefits. **(Chapter 11)**	8	**L3**
Module 4		
AI for the Industrial IoT: Introduction to AI- powered industrial IoT – Use Cases – predictive maintenance using AI, LSTM - Advantages and disadvantages – Electrical load forecasting in industry- STLF using LSTM **(Chapter 10)**	8	**L3**
Module 5		
Anomaly Detection using IOT – Web based mobile health app using ML – Predict equipment failure using IoT sensor data – Analyze industrial equipment for defects –Detect change points in IoT sensor data – Detect voltage anomalies in household IoT devices	8	**L3**

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	Describe the need of Analytics on IoT data.
CO2	Identify different data formats and applications of AI on IoT data
CO3	Understand different domains like Personal healthcare, home, Industrial data and smart cities data.
CO4	Design applications of Industrial IOT.
CO5	Create the role of IOT in Smart cities

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	1		1	1					1			
CO2	2	3	1		1	2					1			
CO3	2	2	3		1	1					1			
CO4	2	1	2		1	1					2			
CO5	2	2	2		2	1					3			

High-3: Medium-2: Low-1

Text Book:

1. Amita Kapoor, — Hands-On Artificial Intelligence for IoTǁ, Packet Publishing, 2019.
2. Andrew Minteer —Analytics for Internet of Thingsǁ — Packt Publishing, 2017

Reference Books:

1. Big–Data Analytics for Cloud, IoT and Cognitive Computing Hardcover –by Kai Hwang (Author), Min Chen (Author).
2. David Hanes , GonzaloS algueiro, Patrick Gross etete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies , Protocols and Use Cases for Internet of Things , Cisco Press , 2017.
3. Pethuru Raj, Anupama C. Raman, The Internet of Things, Enabling Technologies, Platform s, and Use Cases, CRC Press, 2017.
4. Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things Principles and Paradigms, Morgan Kaufmann, 1s t edition, 2016.
5. Marco Schwartz, Internet of Things with Arduino Cookbook, Packt Publishing,2016
6. Adeel Javed, "Building Arduino Projects for the Internet of Things : Experiment s with Real-World Applications", 1s t Edition, Apress , 2016.

Scheme of Examination (CIE):

In order to encourage innovative methods while delivering a course, the faculty members have been encouraged to use the **Alternative Assessment Tool (AAT).** The AAT enhances the autonomy (freedomand

flexibility) of individual faculty and enables them to create innovative pedagogical practices.

Possible AATs are - seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic tool-box for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical evaluation pattern for regular courses is shown in Table 1:

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying 20 marks each.
- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module

INTELLIGENT MULTI AGENT AND EXPERT SYSTEMS

Semester:	VIII	CIE Marks	50
Course Code	21AML823	SEE Marks	50
Hours/Week (L: T: P)	3:0:0	Duration of SEE (hours):	03
Type of Course	PEC	Credits	03

Prerequisites (if any):

Course Learning Objectives:

Sl. No	Course Learning Objectives (CLO)
1	Comprehend the concept of agents, intelligent agent systems, design architectures, agent communication, interaction protocols, key types of possible multi-agent system interaction and agreement
2	Comprehend the concept of expert system, expert system architecture, production rules and implementation tools
3	Apply the principles and methods of intelligent multi-agents and expert systems
4	Synthesize multi-agent expert systems to solve small- or large-scale real-life problems

Module 1	No. of Hours	RBT Level
Introduction to Agents: Agents and Environment; Performance measure; Nature of Environment; Abstract and Concrete Architecture for intelligent agents; Problem solving and planning: Result sharing, Task sharing and Distributed planning	08	L2
Module 2		
The design of Intelligent Agents: Deductive reasoning agents: AgentO, Practical Reasoning Agents: HOMER architecture; Reactive agents: Subsumption architecture; Hybrid agents: TouringMachines, InteRRaP. **Agent Communication and Interaction Protocols:** Agent Communications:Knowledge Query and manipulation Language (KQML), Knowledge Interchange Format (KIF), Ontology, Coordination protocols, Cooperation Protocols, Contract Net, Blackboard Systems, Negotiation, Multi-agent Belief Maintenance, Market Mechanisms	08	L2
Module 3		
Multi-Agent System Interactions & Agreements: Classifying multi-agent interactions: Multi-agent Encounters - Dominant Strategies and Nash Equilibria - Competitive and zero-sum and other interactions; Cooperation: the Prisoner's dilemma and Axelrod's experiments; Reaching Agreements: Interactions between self-interested	08	L2

agentsauctions & voting systems – negotiation - Argumentation; Interactions between benevolent agents: Cooperative Distributed Problem Solving (CDPS), partial global planning; coherence and coordination		
Module 4		
Multi-agent Methodologies and Applications: Agent Methodologies- Mobile agents; Typical application areas of agent systems: Business Process Management, Distributed Sensing, Information Retrieval and Management, Electronic Commerce, Human-Computer Interfaces, Social Simulation etc.	08	L3
Module 5		
Introduction to Expert System Expert System Models: Expert Systems: Introduction, Architecture, Production rules and inference, Basic forms of inference: abduction; deduction; induction. Rule-based representations (with backward and forward reasoning); logic-based representations (with resolution refutation) **Expert System Implementation:** Implementation Tools: Prolog, CLIPS; Study of existing expert systems: MYCIN, DART and XCON	08	L3

Course Outcomes:

Upon successful completion of this course, student will be able to

CO1	**Describe** the notion of an agent, intelligent agent systems characteristics and the structure of agents.
CO2	**Design** intelligent agents that can effectively cooperate in order to solve problems
CO3	**Apply** the concepts of agent communication, interaction protocols, multi-agent interactions and agreements
CO4	**Build** agents capable of intelligent autonomous actions using appropriate methodologies
CO5	**Develop** novel applications using intelligent multi-agent expert systems to solve real-life problems

	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO1	3				0	1	0	0	1	0	0	1	0	0
CO2	3	3	3		0	1	0	0	1	0	0	3	0	0
CO3	3		3	3	0	3	0	0	3	0	0	1	0	0
CO4	3		3	3	0	1	0	0	2	0	0	1	0	0
CO5	3				0		0	0		0	0		0	0

High-3: Medium-2: Low-1

Texts Books:

1. Michael Wooldridge, —An Introduction to Multi Agent Systems‖, Second Edition, Wiley, 2009.
2. G. Weiss (ed.), —Multi-Agent Systems - A Modern Approach to Distributed Artificial Intelligence‖, (2nd Ed.). MIT Press, 2013.
3. Dan W. Patterson, —Introduction to AI & Expert System‖, PHI, 2007

References:

1. Stuart Russell and Peter Norvig, —Artificial Intelligence - A Modern Approach‖, 3rd edition, Prentice Hall, 2011.
2. D. Poole and A. Mackworth, —Artificial Intelligence: Foundations of Computational Agents‖, Cambridge University Press, 2010
3. Yoav Shoham and Kevin Leyton-Brown, —Multiagent Systems: ‖, Cambridge University Press, 2009.
4. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
5. Dennis Merritt, —Building Expert Systems in Prolog‖, Amzi! inc., 2000.
6. J. Giarratano and G. Riley, "Expert Systems - Principles and Programming". 4th Edition, PWSPublishing Company, 2004.
7. Peter J.F. Lucas & Linda C. Van der Gaag, —Principles of Expert Systems‖, Addison-Wesley, 1991

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	CIE Test-2	40	
	CIE Test-3	40	
	QUIZ/Assignment	10	
SEE	Semester End Examination	100	50
	Grand Total		100

Note: CIE pattern for courses like Drawing and Laboratories can be decided by the respectiveBoard of Studies and can be given here.

Scheme of Examination (SEE):

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
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- There will be two full questions (with a maximum of four sub questions) from each module.
- The students will have to answer five full questions, selecting one full question from each module

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