GANPAT UNIVERSITY									
FACULTY OF ENGINEERING & TECHNOLOGY									
Programme	Master of Technology					Branch/Spec.	Electronics and Communication Engineering – Embedded System		
Semester	II					Version	1.0.0.0		
Effective from Academic Year	2026-27					Effective for the Batch admitted in			July 2026
Course Code	3ES2103		Course Name			Machine Learning for Embedded Devices			
Teaching Scheme						Examination Scheme (Marks)			
(Per week)	Lecture(DT)		Practical(Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	3	0	1	-	4	Theory	50	50	100
Hours	3	0	2	-	5	Practical	25	25	50

Pre-requisites

Basic Programming (C/Python), Data Structures, Mathematics (Linear Algebra, Probability, and Statistics), Embedded Systems Fundamentals, and IoT Concepts.

Course Outcomes

On successful completion of the course, the students will be able to:

CO1	Understand TinyML concepts, embedded machine learning workflows, and challenges involved in deploying ML models on resource-constrained devices.
CO2	Develop optimized machine learning models using sensor data preprocessing, feature extraction, quantization, and TensorFlow Lite Micro frameworks.
CO3	Deploy and evaluate machine learning inference applications on embedded hardware platforms such as ARM Cortex, STM32, and ESP32 devices.
CO4	Understand and apply fundamental machine learning concepts for embedded devices by analysing data, selecting appropriate lightweight algorithms, and implementing efficient models for resource-constrained hardware systems.

Theory Syllabus

Unit	Content	Hrs.
1	**Introduction to TinyML:** Introduction to Machine Learning for Embedded Systems, Evolution of Embedded Artificial Intelligence, Fundamentals of TinyML, Machine Learning Workflow for Embedded Devices, TinyML vs Cloud-Based Machine Learning, Characteristics of Embedded ML Systems, Resource Constraints in Embedded Devices, Memory and Power Limitations, Real-Time Inference Requirements, Edge AI and Edge Computing Concepts, Embedded AI Hardware Platforms, Microcontrollers for TinyML Applications and TinyML Software Ecosystem, Embedded ML Frameworks Overview and AI Acceleration Techniques.	8
2	**Data Handling:** Importance of Data in Embedded ML, Sensor Data Acquisition Techniques, Data Logging from Embedded Sensors, Analog and Digital Sensor Data Collection, Time-Series Data Fundamentals, Data Sampling and Windowing, Data Labelling Techniques and Data Cleaning and Noise Reduction, Feature Extraction Fundamentals and Statistical Feature Extraction, Frequency Domain Features, Signal Processing Basics for TinyML, Data Normalization and Scaling, Embedded Data Preprocessing Techniques, Memory-Efficient Data Handling.	7
3	**Model Optimization:** Introduction to Neural Networks, Perceptron and Multi-Layer Neural Networks, Activation Functions and Loss Functions, Embedded Neural Network Architectures, Lightweight ML Models for TinyML, Convolutional Neural Networks (CNNs) Basics, Model Compression Techniques and Quantization Techniques, Integer and Fixed-Point Inference, Model Pruning Concepts and Sparse Neural Networks, Knowledge Distillation Basics.	10
4	**Deployment on Hardware:** Embedded ML Deployment Workflow, TensorFlow Lite Micro Runtime, Embedded AI Deployment Architectures, Inference on ARM Cortex-M Processors, STM32-Based TinyML Deployment, ESP32-Based TinyML Applications, Memory Allocation for	10

	Inference, Embedded Model Execution Flow, Hardware Acceleration Techniques, DSP Support for ML Inference, Real-Time Embedded Inference, Power Consumption Analysis, Latency and Throughput Measurement.	
5	**Applications & Projects:** TinyML Application Development, Audio and Speech Recognition Systems, Keyword Spotting Techniques, Gesture Recognition Systems, Predictive Maintenance Concepts, Vibration Signal Analysis, Smart Health Monitoring Applications, TinyML in Industrial IoT, Environmental Monitoring Systems. **Mini Project:** TinyML-Based Smart Predictive Monitoring System.	10
Practical Content		
Practical, assignments and tutorials are based on above syllabus.		
Text Books		
1	Pete Warden & Daniel Situnayake – TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, O'Reilly.	
Reference Books		
1	Ethem Alpaydin – Introduction to Machine Learning, MIT Press.	
2	Laurence Moroney – AI and Machine Learning for On-Device Development, O'Reilly.	
ICT/MOOCs Reference		
1	https://www.youtube.com/watch?v=RDGCGho5oaQ&list=PL7VEa1KauMQqZFj_nWRfsCZNXaBbkuurG&index=3	

Mapping of CO with PO and PSO :															
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	3	3	2	3	2	2	2	3	1	1	1	2
CO2	2	2	2	2	2	3	2	3	3	3	2	2	2	2	1
CO3	3	3	3	3	3	2	2	3	3	2	2	1	1	1	2
CO4	3	1	3	3	2	2	3	1	3	2	2	3	3	3	2