# INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

## COURSE CONTENT

| EMBEDDED SYSTEMS FOR MACHINE LEARNING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **II Semester:** ES | | | | | | | | |
| **Course Code** | **Category** | **Hours / Week** | | | **Credits** | **Maximum Marks** | | |
| | | **L** | **T** | **P** | **C** | **CIA** | **SEE** | **Total** |
| **BESE15** | **Elective** | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **Contact Classes: 45** | **Tutorial Classes: Nil** | **Practical Classes: Nil** | | | | **Total Classes: 45** | | |
| **Prerequisite: Embedded Systems, Real-time Operating Systems.** | | | | | | | | |

### I. COURSE OVERVIEW:
This course aims to provide students with a solid foundation in embedded systems for machine learning. Students will learn about the design, development as well as the key components involved in creating efficient and reliable embedded solutions. This course aims to provide students with the skills needed to design and implement machine learning applications on embedded systems, taking into consideration the unique challenges posed by resource-constrained environments.

### II. COURSES OBJECTIVES:
**The students will try to learn**

I. The difference between embedded systems and general-purpose systems.
II. Develop an understanding of hardware/software co-design and its significance.
III. Implement basic networking and communication capabilities in embedded systems.
IV. Define and explain the fundamental concepts of machine learning.
V. Provide an overview of the historical context and evolution of machine learning.

### III. COURSE OUTCOMES:
**At the end of the course students should be able to:**

CO 1 Describe the characteristics, challenges, and constraints of embedded systems.
CO 2 Apply the suitable memory technology and other components for different applications to meet the ever-growing needs of the embedded applications.
CO 3 Choose the fundamental components that make up an embedded board to implement an Instruction Set Architecture ‘s features in a processor.
CO 4 Apply machine learning techniques on appropriate problems.
CO 5 Apply Evaluation, hypothesis tests and compare learning techniques for various problems.
CO 6 Analyze real time problems in different areas and solve using Reinforcement learning technique.

### IV. COURSE CONTENT:
**MODULE - I: INTRODUCTION TO EMBEDDED SYSTEMS (9)**
Overview of microcontrollers and microprocessors Architecture, memory organization, and I/O operations, Selection criteria for choosing microcontrollers, definition and characteristics of embedded systems.

**MODULE –II: TYPICAL EMBEDDED SYSTEM (9)**
Core of the Embedded System: General purpose and domain specific processors, ASICs, PLDs,

commercial off- the-shelf components (COTS), memory: ROM, RAM, memory according to the type of interface, memory shadowing, memory selection for embedded systems, sensors and actuators, communication interface: onboard and external communication interfaces.

**MODULE –III: INTRODUCTION TO MACHINE LEARNING (9)**

Introduction: Examples, Applications of Machine Learning Applications - Learning Associations, Classification, Regression, Unsupervised learning, Reinforcement learning.

**Supervised Learning:** Regression: Introduction to Linear Regression and Multiple Linear Regression, KNN. Measuring regression model performance - R Square, Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE). **Classification**: Support vector machine-Characteristics, Linear SVM, Naive Bayes Classifier, KNN classifier, Logistic Regression. Measuring Classifier Performance: Precision, Recall, and Confusion Matrix.

**MODULE –IV: CLASSIFICATION ALGORITHMS (9)**

Classification algorithms, naïve Bayes: the basics of Bayes Theorem, Naïve Bayes classifier and implementation in a Spam-Ham classifier, K-Nearest Neighbours Computational geometry; Voronoi Diagrams, Delaunay Triangulations, K-Nearest Neighbour algorithm; Wilson editing and triangulations

**MODULE –V: UNDERSTANDING GPT (GENERATIVE PRE-TRAINED TRANSFORMER) (9)**

Understanding GPT (Generative Pre-trained Transformer): Introduction to GPT and its significance, Pretraining and fine-tuning processes in GPT, Architecture and working of GPT models, Overview of GPT variants and their use cases, Auto encoders and Generative Models: Auto-encoders and unsupervised learning, Variational Auto encoder , Generative Adversarial Networks (GANs)

## V. TEXT BOOKS:


1. Frank Vahid, Tony Givargis, "Embedded System Design", John Wiley Publications, 3rd Edition, 2006.
2. Introduction to Machine Learning, Ethem Alpaydin, 2nd Edition, 2010, Prentice Hall of India.
3. Introduction to Data Mining, Tan, Vipin Kumar, Michael Steinbach, 9th Edition, 2013, Pearson.


## VI. REFERENCE BOOKS:


1. Raj Kamal, "Embedded Systems", TMH, 2nd Edition, 2008.
2. Shibu K.V, "Introduction to Embedded Systems, McGraw Hill, 3rd Edition, 2012.
3. Lyla, "Embedded Systems", person education, 2nd Edition, 2013.
4. Machine Learning a Probabilistic Perspective, Kevin P Murphy & Francis Bach, 1st Edition, 2012, MIT Press.
5. "Deep Learning", Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, MIT Press.


## VII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Assignments
4. Model question paper - I
5. Model question paper - II
6. Lecture notes
7. Power point presentations
8. Early Lecture Readiness Videos