Program Description Document Template

Course Name	Certificate Programme in Deep Learning and AI
Course Name as on Certificate	Certificate Programme in Deep Learning and AI
Certificate Type	Digital Copy
Certificate Issued by	Certificate of Completion issued jointly by IITM Pravartak and Centre of Outreach and Digital Education (CODE) IIT Madras
Course Objectives	The Programme aims to teach the fundamentals of deep learning and applications of deep learning models for AI tasks related to text processing and image and video processing. The Programme will help develop capabilities to build deep learning models for real-world problems.
Eligibility	B.E., B.Tech., MCA, or MSc (CS or IT) Graduates as on the Programme Start date, i.e., Technical Orientation Date
Pre Requisites	Candidate should have a basic understanding of mathematic topics such as Linear Algebra, Calculus, Probability and Statistics; Familiar with programming in either C or Python or MATLAB
Target Segment	Learners aspiring to gain technical capabilities to build Deep Learning Models for Real-World Problems
Course Content	**See Enclosed Progamme details – as Annexure 1**
Pedagogy	This high-rigour programme is taught through 15 high-impact modules and includes multiple hands-on assignments, examinations, live online classes by eminent IIT Madras faculties, discussions on Deep Learning Tools, and immersion at IIT Madras campus including hackathon
Assessment	3 Programming Assignments (20 marks each): Total of 60 marks *Assignment 1: Post module 5 and 6* *Assignment 2: Post module 7 and 8* *Assignment 3: Post module 10,11 and 12* 3 Quizzes (One hour exam) (20 marks each): 60 marks *Quiz 1: Post module 6,* *Quiz 2: Post module 9,* *Quiz 3: Post module 12* Hackathon: Post module 13 (2 consecutive days): 30 marks End Sem Exam: All Modules (Three Hour Exam): 50 marks
Programme Faculty	Prof. C. Chandra Sekhar
Duration	150 Hours covered across 10 months (Includes 10 Hours of Examination)
Class Schedule	Total Number of Hours Total of 150 hrs through the Emeritus Platform on Weekend (Direct to Device Classes) ➢ IITM Faculty Teaching Hours: 129 hours

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<tr><td></td><td>➢ Campus Hours: 21 hours
Total of 126 hrs through the Emeritus Platform on Weekends (Platform Classes)

4 - hours of weekly Platform classes every Saturday and Sunday 03:30 pm to 05:30 pm</td></tr>
<tr><td>Programme Highlights/USPs</td><td>Programme USP
• A campus Immersion of 4 days at IIT Madras
• Hands-on Projects/ Assignments using deep learning tools
• Access to Labs in the CSE Department of IIT Madras
• Hackathon

Programme Learning Outcomes
• Understand different neural network architectures and models
• Identify appropriate deep learning algorithms suited for various learning tasks
• Understand the data requirements of machine and deep learning models
• Perform classification and regression using Artificial neural networks
• Execute Implement methods of optimization, regularization, and fine tuning for DFNNs
• Working knowledge of transformer models and autoencoders
• Design and execute CNN from texts, images, and videos
• Design and analyse RNN for natural language classification, generation, and translation
• Evaluate encoder-decoder based deep learning models
• Gain exposure to GANs and deep reinforcement learning
• Build deep tech capabilities to execute deep learning on real world problems</td></tr>
<tr><td>Total Fees</td><td>
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<tr><td></td><td>Total Fees (Rs.)</td><td>INR 2,00,000 + GST</td></tr>
<tr><td>Total Programme Fee</td><td colspan="2">
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<tr><th>Particulars</th><th>Total Fees (Rs.)</th></tr>
<tr><td>Application Fees</td><td>INR 1,500 + GST</td></tr>
<tr><td>Payment Facilitation Charges</td><td>INR 4,800 + GST</td></tr>
<tr><td>Programme Fee</td><td>INR 1,95,200 + GST</td></tr>
<tr><td>Total fee (Excl. App Fee)</td><td>INR 2,00,000 + GST</td></tr>
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ANNEXURE 1

Proposed Course outline / programme / plan - Week wise or module wise syllabus details.

Module #	Modules	Sub-Modules
1	Introduction to Programme	Motivation for Programme, Overview of Programme, Expected Outcomes of Programme
2	Machine learning tasks and applications	Function approximation (Regression), Classification, Clustering, Ranking, Information retrieval. Text processing applications - Text classification, Parts-of-speech tagging, Named entity recognition, Text summarization, Text question answering, Machine translation; Image and video processing applications: Image classification, Image annotation, Image captioning, Video classification, Video captioning, Visual question answering, Visual common sense reasoning; Speech processing applications - Speech recognition, Speaker recognition, Speech emotion recognition, Spoken language recognition, Text-to-speech synthesis, Speech-to-speech translation; Data representation - Feature extraction, Representation learning, Embeddings
3	Paradigms of machine learning	Supervised learning, Unsupervised learning, Semi-supervised learning, Active learning, Self-supervised learning, Transfer learning, Domain adaptation - Zero-shot, One-shot and Few-shot learning; Federated learning
4	Review of basics of mathematical topics	Linear Algebra: Vectors and Matrices, Inner product of vectors, Matrix multiplication by a vector, Eigen values and vectors of a matrix, Singular value decomposition of a matrix
		Calculus: Differentiation with one variable, Differentiation with multiple variables, Differentiation of a vector and a matrix, Unconstrained optimization problem solving
		Probability and Statistics: Random variables, First order and second order statistics, independent variables, Uncorrelated variables, Sum and Product Laws of probability, Probability distributions, Bayes rule
5	Regression methods	Linear model for regression, Supervised learning, Parameter estimation - Maximum likelihood method, Overfitting, Regularization, Ridge regression, Lasso
6	Probabilistic models for classification	K-nearest neighbour classifier, Bayes classifier, Normal density function, Maximum likelihood estimation, Gaussian mixture model, Naïve Bayes classifier, Decision surfaces, Dimension reduction methods - Principal component analysis, Linear discriminant analysis

7	Artificial neural networks for classification and regression	McCulloch-Pitts neuron, **Perceptron learning rule**, Perceptron convergence theorem, Sigmoidal neuron, Softmax function, Multilayer feedforward neural network, Error backpropagation method, Gradient descent method, **Stochastic gradient descent method**, Stopping criteria, Logistic regression based classifier
8	Optimization and regularization methods for DFNNs	Deep feedforward neural networks (DFNNs), Optimization methods: **Generalized delta rule**, AdaGrad, RMSProp, Adadelta, AdaM, Second order methods; Regularization methods: Dropout, Dropconnect; Batch normalization
9	Autoencoders	Auto associative neural network, stacked autoencoder, Greedy layer-wise training, Pre-training of a DFNN using a stacked autoencoder, Fine tuning a DFNN, Regularization in autoencoders, Denoising autoencoder, Variational autoencoder
10	Convolutional neural networks (CNNs)	Basic CNN architecture, Rectilinear Unit (ReLU), 2-D Deep CNNs: LeNet, AlexNet, VGGNet, GoogLeNet, ResNet; Image classification using 2-D CNNs; 3-D CNN for video classification; 1-D CNN for text and audio processing; Vector of Linearly Aggregated Descriptors (VLAD) method for aggregation - NetVLAD
11	Recurrent neural networks (RNNs)	Architecture of an RNN, Unfolding an RNN, Backpropagation through time, Vanishing and exploding gradient problems in RNNs, Long short term memory (LSTM) units, Gated recurrent units, Bidirectional RNNs, Deep RNNs
12	Encoder-decoder paradigm based deep learning models	Encoder-decoder paradigm, Image and video captioning models, Machine translation, Text processing models, Representation of words: Word2Vec, GloVe
13	Transformer models	Attention based models, Scaled dot product attention, Multi-head attention (MHA), Self-attention MHA, Cross-attention MHA, Position encoding, Encoder and Decoder modules in a transformer, Sequence to sequence mapping using transformer, Machine translation using transformer model, Vision transformer for image classification, Video captioning using transformer model, Bidirectional encoder representations from transformers (BERT) model for text processing, Pre-training a BERT model, Fine tuning a BERT model for text processing tasks, Vision-and-Language BERT (ViLBERT) for image and video processing tasks, Text and Visual question answering and reasoning using transformer models
14	Generative adversarial networks (GANs)	Image generation models, Architecture and training of a GAN, Deep convolutional GAN, Cyclic GAN, Conditional GAN, Super-resolution GAN, Applications of GANs for image processing
15	Reinforcement Learning	Introduction to reinforcement learning, Markov decision processes, Policy gradients, Temporal difference learning, Q-learning, Deep reinforcement learning - Deep policy gradient, Deep Q learning; Text processing using deep reinforcement learning - Text classification, Text summarization