CERTIFICATE

I certify that the thesis entitled **"Classification of Diabetic Retinopathy Stages using Deep Learning Architectures"**, submitted for the degree of **Doctor of Philosophy (Ph.D.) in Electronics and Communication Engineering**, is the record of research work carried out by **Ms.K.Santhiya Lakshmi** (21PHELF001) during the period of her study from July 2021 to August 2025 in the Department of Electronics and Communication Engineering at Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, under my guidance and supervision and the thesis has not formed the basis for the award of any degree / Diploma / Associateship /Fellowship or any other similar titles of any candidate of this institute or any other University/Institution of Higher Learning.

14/8/25

Signature of the Supervisor

14/8/25

Signature of the HoD

14/8/2025

Signature of the Dean

DECLARATION

I, Ms.K.Santhiya Lakshmi hereby declare that the thesis entitled **"Classification of Diabetic Retinopathy Stages using Deep Learning Architectures"** submitted to the Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, in partial fulfillment of the requirements for the award of the Degree of **Doctor of Philosophy (Ph.D.) in Electronics and Communication Engineering** is a record of original and independent research work carried out by me during the period from July 2021 to August 2025 under the guidance of **Dr. B. Sargunam** B. E., M. E., Ph.D, Professor, Department of Electronics and Communication Engineering, School of Engineering, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore and has not formed the basis for the award of any degree / Diploma / Associateship / Fellowship or any other similar titles in this Institute or any other University / other similar Institution of Higher Learning.

K. Santhiya Lakshmi 14/8/25

Signature of the Research Scholar

Sargu 14/8/25

Signature of the Supervisor

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Ms.K.Santhiya Lakshmi

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AOCT	Angiography Optical Coherence Tomography
ANN	Artificial Neural Network
APTOS	Asia Pacific Tele-Ophthalmology Society
AUC	Area Under the Curve
Anti-VEGF	Anti - Vascular Endothelial Growth Factor
BN	Batch Normalization
BR	Bayesian Regularization
CAD	Computer-Aided Diagnosis
CDAN	Cross-Disease Attention Network
CLAHE	Contrast Limited Adaptive Histogram Equalization
CNN	Convolutional Neural Network
CRT	Central Retinal Thickness
CT	Computed Tomography
CWS	Cotton Wool Spots
CV	Computer Vision
DCNN	Deep Convolutional Neural Networks
DL	Deep Learning
DLC	Directional Local Contrast
DM	Diabetes Mellitus
DME	Diabetic Macular Edema
DR	Diabetic Retinopathy
DRD 0	Diabetic Retinopathy Database 0
DRD 1	Diabetic Retinopathy Database 1
DRIVE	Digital Retinal Images for Vessel Extraction
EXs	Exudates
FA	Fluorescein Angiography
FC	Fully Connected Layer

FLOP	Floating Point Operations
FP	Fundus Photography
FPI	False Positive per Image
FPN	Feature Pyramid Network
FROC	Free response Receiver Operating Characteristic
GAP	Global Average Pooling
GD	Gestational Diabetes
GCN	Graph Convolutional Networks
GMSV	Gradient-based Multi-Scale network Visualization
Grad-CAM	Gradient-Weighted Class Activation Mapping
HEF	Hand-Engineered Features
HEMs	Hemorrhages
HRF	High-Resolution Fundus
ICDR	International Clinical DR
IDE	Integrated Development Environment
ILSVRC	ImageNet Large Scale Visual Recognition Challenge
IOP	Intra Ocular Pressure
ISR	Image Super-Resolution
k-NN	k-Nearest Neighbors
LESH	Local Energy-Based Shape Histogram
LM	Levenberg Marquardt
LRN	Local Response Normalization
MAs	Microaneurysms
MBGL	Modularity-Based Graph-Learning
MESSIDOR	Methods for Evaluating Segmentation and Indexing Dedicated to Retinal Ophthalmology
ML	Machine Learning
MLP	Multi-Layer Perceptron
MSE	Mean Square Error
MRI	Magnetic Resonance Imaging

NAS	Neural Architecture Search
NP	Non-Proliferative
NV	Neo Vascularization
OCT	Optical Coherence Tomography
PDR	Proliferative Diabetic Retinopathy
PHC	Primary Health Care
PSNR	Peak Signal-To-Noise Ratio
RAM	Random Access Memory
RBF	Radial Basis Function
RBM	Restricted Boltzmann Machines
R-CNN	Region-Based CNN
ReLU	Rectified Linear Units
RF	Random Forest
ROI	Region Of Interest
RPN	Region Proposal Networks
RMS	Root Mean Square
RNN	Recurrent Neural Networks
SGD	Stochastic Gradient Descent
SMO	Sequential Minimal Optimization
SSAE	Stacked Sparse Auto-Encoder
SSF	Seven Standard Fields
STARE	Structured Analysis of the Retina
SVM	Support Vector Machine
TL	Transfer Learning
VGG-16	Visual Geometry Group -16
WHO	World Health Organization
YOLO	You Only Look Once