🧠 IT362 – ARTIFICIAL INTELLIGENCE & MACHINE LEARNING PRACTICAL EXAM – SET 2

Exam Mode: Individual Practical **Duration: 3 Hours** **Total Marks: 20**

Smart Roadside Vision for Traffic Sign Recognition

A city authority is piloting smart roadside cameras to assist driver-assistance systems by detecting and classifying traffic signs in real time. Camera feeds contain varied illumination, motion blur, partial occlusions, and perspective distortions. You are engaged to prototype an image-understanding pipeline that can reliably assign each cropped sign image to one of 43 official categories.

Your solution must generalize across diverse conditions and provide interpretable evidence of what visual patterns (pictograms, borders, numerals) drive decisions.

🚫 Academic Integrity & AI-Use Policy

Use of AI-assisted tools (ChatGPT, Gemini, Copilot, Claude, etc.) or copied code is strictly prohibited.

Detected AI-generated or copied work will be treated as UFM (Unfair Means) and awarded zero marks.

💬 Declaration (required in first cell): "I, <Full Name & Roll No>, confirm that this notebook was completed independently without AI or external code assistance."

💾 File Naming & Submission Format

Submit a ZIP file named:

RollNo_Set1_IntelImage.zip

Containing:

- **RollNo_Set1_IntelImage.ipynb (notebook with code + markdown)**
- **Exported .html version**
- **Trained model file (.h5)**
- **reflection.txt (≈ 150 words)**

Upload to Google Classroom before deadline. Late or mis-named submissions will not be accepted.

🌐 Dataset Access & Download

Dataset: Intel Image Classification

Official Source: https://www.kaggle.com/datasets/puneet6060/intel-image-classification

🧩 TASKS

1. Dataset Exploration & Audit
    - What is the class distribution and where do you observe imbalance?
    - What variations (scale, rotation, lighting, motion blur) are evident, and how might these affect learning?
    - Which preprocessing choices (resize size, color handling, normalization) are justified for sign imagery?
2. Data Preparation & Preprocessing
    - What target resolution will you use (e.g., 48×48, 64×64), and why is it appropriate for small glyphs and borders?
    - Which normalization and augmentation operations (affine transforms, brightness/contrast, slight blur) best model real roadside conditions without corrupting semantics?
    - How will you stratify train/validation/test to keep class balance and avoid leakage?
3. Feature Reasoning & Model Design
    - Which low-level features (edges, corners, color borders) and mid-level motifs (triangles, circles, numerals) should the system capture?
    - How will you structure your network block-by-block so it remains compact yet discriminative for 43 classes?
    - Which loss, optimizer, and LR schedule suit this task, and why (consider label smoothing/weight decay)?
4. Training Plan & Monitoring
    - What batch size and epoch budget will you start with, and how will you tune them?

- Which early-stopping and LR scheduling signals will you monitor from curves to detect over/underfitting?
- If training diverges or plateaus, what is your first corrective step and why?

5. Performance Evaluation & Error Analysis
    - Which metrics (overall accuracy, macro-F1, confusion matrix) best reflect performance across given categories?
    - Which top three confusion pairs appear and what visual reasons explain them (border color, numeral thickness)?
    - What data or model changes (extra augmentation, slightly larger input, class weights) could reduce those confusions?
6. Explainability & Interpretation
    - Using Grad-CAM/activation maps, which regions (numerals, border, pictogram) drive correct vs incorrect predictions?
    - If the model focuses on background or irrelevant areas, what does that imply about your preprocessing/design, and how would you fix it?
7. Reflection & Safety Considerations
    - Which single design decision most improved reliability?
    - What limitations remain (glare at night, motion blur)?
    - In deployment, which is riskier—false positives or false negatives—for traffic signs, and how would you mitigate that?
