Middle East Technical University
Department of Mechanical Engineering
ME 485-CFD using FVM
Fall 2024
Homework 1

Your task is to integrate gradient computation methods into the *mefvm* code. Below are the key steps and deliverables:

Steps to Complete the Homework

1. **Retrieve Code:**
   - Download the initial code version from the GitHub repository: GitHub Link.
   - Ensure you work within the branch **HW1**.
2. **Complete Missing Implementations:**
   - Navigate to the *solvers/grad* folder.
   - Implement the following in the *GradElements* class (located in *elements.py*):
     - *_make_compute_fpts*: Assign cell center values to element faces.
     - *_make_grad_gg*: Compute Green-Gauss-Cell based gradient without correction.
     - *_grad_operator*: Construct the operator for least-squares and weighted least-squares gradients.
     - *_make_grad_ls*: Compute gradients using least-squares methods.
     - *compute_L2_norm*: Calculate the L_2 error norm assuming the exact solution is known.
   - Implement the following in the *GradIntInters* class (located in *inters.py*):
     - *_make_delu*: Compute the difference of face values at element interfaces.
     - *_make_avgu*: Compute the average face value at element interfaces.
   - Implement the following in the *GradBCInters* class (located in *inters.py*):
     - *_make_delu*: Compute the difference of face values at boundary faces.
     - *_make_avgu*: Compute the average face value at boundary faces.
3. **Run and Test the Code:**
   - Check the provided *grad.ini* file (in the *solvertests* folder) and the sample script *grad_test_mesh.py* to generate a sample test meshe.

- Execute the gradient solver using the driver script *grad_test.py*.
- Perform tests across:
  - Mesh types: Triangles, quadrilaterals, structured, unstructured.
  - Field types: Low/high-order polynomials, trigonometric functions, etc.
  - Boundary conditions: Different configurations.

4. **Error Computation and Reporting:**
   - Compute the L_2 error norm between exact and approximate solutions.
   - Document your implementation process, results, and findings in a detailed report.
   - Ensure the report includes:
     - Implementation details.
     - Observations from tests on various meshes and fields.
5. **Submit Your Work:**
   - Provide the **complete code** (all folders) to allow replication of results.
   - Submit a **PDF report** (other formats are not accepted).

Good luck!