**UNIVERSITY OF MOHAMED KHIDER - BISKRA**
**FACULTY OF SCIENCE AND TECHNOLOGY**
**DEPARTMENT OF MECHANICAL ENGINEERING**

**MASTER II - MECHANICAL ENGINEERING**
**SPECIALTY: ENERGETICS**

**FIRST EXAM: FEBRURY 02, 2022**
**COMPUTATIONAL FLUID DYNAMICS ("CFD et Logiciels")**
**Time Allowed: 1 hour**

# TYPICAL CORRECTION OF EXAM

## PART ONE – GENERAL QUESTIONS (09 pts)

### What is CFD? (03 pts)

- CFD is the simulation of fluids engineering systems using modeling (mathematical physical problem formulation) and numerical methods (discretization methods, solvers, numerical parameters, and grid generations, etc.)
- Historically only Analytical Fluid Dynamics (AFD) and Experimental Fluid Dynamics (EFD).
- CFD made possible by the advent of digital computer and advancing with improvements of computer resources

(500 flops, 1947→20 teraflops, 2003 →1.3 pentaflops, Roadrunner at Las Alamos National Lab, 2009.)

### Why use CFD? (04 pts)

- Analysis and Design

1. Simulation-based design instead of "build & test"
   - ❑ More cost effective and more rapid than EFD
   - ❑ CFD provides high-fidelity database for diagnosing flow field
2. Simulation of physical fluid phenomena that are difficult for experiments
   - ❑ Full scale simulations (e.g., ships and airplanes)
   - ❑ Environmental effects (wind, weather, etc.)
   - ❑ Hazards (e.g., explosions, radiation, pollution)
   - ❑ Physics (e.g., planetary boundary layer, stellar evolution)

- Knowledge and exploration of flow physics

### Where is CFD used? (02 pts)

- CFD used in many domains such as:
  - Aerospace
  - Automotive
  - Biomedical
  - Chemical Processing
  - HVAC
  - Hydraulics
  - Marine
  - Oil & Gas
  - Power Generation
  - Sports

## PART TWO – CONCEPTS DEVELOPMENT (11 pts)

### Modeling (03.50 pts)

- Modeling is the mathematical physics problem formulation in terms of a continuous initial boundary value problem (IBVP)
- IBVP is in the form of Partial Differential Equations (PDEs) with appropriate boundary conditions and initial conditions.
- Modeling includes:

1. Geometry and domain
2. Coordinates
3. Governing equations
4. Flow conditions
5. Initial and boundary conditions
6. Selection of models for different applications

### Numerical methods (02 pts)

- The continuous Initial Boundary Value Problems (IBVPs) are discretized into algebraic equations using numerical methods. Assemble the system of algebraic equations and solve the system to get approximate solutions
- Numerical methods include:

1. Discretization methods
2. Solvers and numerical parameters
3. Grid generation and transformation
4. High Performance Computation (HPC) and post-processing

### CFD Process (05.50 pts)

- Once purposes and CFD codes chosen, "CFD process" is the steps to set up the IBVP problem and run the code: