

**FINAL EXAM - OPEN PART**

Lecturer: Prof. Jin HUANG

**Instructions:**

- This is the open part of the final exam. You can finish the problems in one week.
  - You can refer to any material.
  - Teamwork is NOT allowed. You should NOT discuss these problems with ANYONE.
  - DUE June 28 before 11:59pm.
  - Answer in English. Font size should be 12pt. No more than 4 pages.
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**Problem 1.** (20pts) Read papers or documents about “complex-step finite difference” or “complex-step derivative approximation”.

- ▶ (10pts) Derive the error  $e(h)$  of using this method on computing  $\frac{d \tan(x)}{dx}$  with step size  $h$ .
- ▶ (10pts) Discuss the advantage and disadvantage of this method compared with common finite difference method.

**Problem 2.** (20pts) For linear equation  $Ax = b$ , some solvers are applicable only when  $A$  is SPD matrix.

- ▶ (5pts) Please list a few such solvers.
- ▶ (5pts) One possible way to use such solvers is to turn the linear equation into  $(A^T A)x = A^T b$ . Compare the condition number under  $\ell^2$  norm of  $A$  and  $A^T A$ .
- ▶ (10pts) If there are zeros in the diagonal of  $A$ , many iteration methods (e.g. Jacobian iteration) do not work. Please introduce an iteration method for such problem.