Numerical Methods in Engineering Sciences
26/2/2021

Written Exam

First name: _____

Last name: _____

Student ID: _____

☐ I want to take the BASIC EXAM
☐ I want to take the ADVANCED EXAM

Exam rules:

- Basic exam: the maximum grade is 24/30.

- Advanced exam: the maximum grade is 30/30 cum laude.

Total time is 1 hour. Students who get a positive grade in the written part (i.e., at least 18/30) *might* choose to take an oral exam. For students who choose the basic written exam, the maximum grade obtainable can never exceed 24/30.

## BASIC EXAM

**1.** Compute the linear regression $r(x) = c_0 + c_1 x$ for the set of points

$$(-3, 0), \ (-2, 0), \ (-1, 3), \ (1, 1), \ (2, 1), \ (3, 2).$$

**2.** Describe the Crank-Nicolson scheme for the solution of an ODE and explain its relation with the trapezoidal quadrature rule. Report its pseudocode. Finally, compute one step of the Crank-Nicolson scheme for the problem

$$\begin{cases} y'(t) = e^{-t} y(t) \\ y(0) = 1 \end{cases}$$

with step-size $\Delta t = 1$.

## ADVANCED EXAM

**3.** Describe the LU-based algorithm that computes the inverse of a matrix $A$. Give its pseudocode that should include the LU factorization part (it could be with or without pivoting, your choice) and give an estimate of its computational cost

**4.** Write the pseudocode of the bisection method. Apply two bisection iterations to the equation

$$x^3 + 1 = 0 \qquad in \ [-2, 2].$$