Scientific Computing
Lecture 3

Exam questions

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October 5, 2021

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Questions

- Write the definition of a linear space. Find the example of linear space.
- Write the definition of metric space. Find the example of it.
- Write the definition of complete space. Find the example of it.
- What is norm? List the properties of norm.
- Write the definition of a Banach space. Find the example of it.
- What is inner product? List the properties of inner (scalar) product.
- Write the definition of a Hilbert space. List two examples of Hilbert space from the lecture.
- Find the example of the space, which is Banach space, but not Hilbert space.
- How do spaces $C[a, b]$ and $C^m[a, b]$ are connected to each other. Write the norms in each one and explain, why do these spaces are important for research of scientific computing problems.
- How do spaces $L_p[a, b]$ and $H^1[a, b]$ are connected to each other? Write the norms and explain why do these spaces are important for scientific computing.
- Write the generalized matrix form of the SLAE; explain all its parts.
- What properties of the matrix of SLAE do you know? List them.
- List two kinds of computational methods for SLAE. Give some examples.
- Which SLAE do need the regularization? List three kinds of these systems and explain what do these kinds mean in terms of the matrix of the system.
- Describe four steps of computational solution of the scientific computing problem with usage of mesh.
- Suppose the computational domain is covered with a uniform mesh. How can you approximate the first derivatives of some function (defined in this domain) with FDM?
- Suppose the computational domain is covered with a uniform mesh. How can you approximate the second derivatives of some function (defined in this domain) with FDM?
- Describe the "cross" template for approximation of second derivatives; write the approximation of Poisson equation using this template.
- When should you use non-uniform meshes in FDM? When it is not reasonable to use them (in FDM)?
- Describe the procedure (steps) of reduction the problem for differential equation to SLAE using FDM.

Questions

- Describe general properties of FDM matrix for Poisson equation, obtained using the Cross template.
- Why it is better to avoid usage of inverse matrices in real computations of Poisson equation with the Cross template?
- List the advantages of Finite Element Method (FEM).
- Describe the parts of FEM mesh in terms of nodes, elements.
- What is the basis function in FEM? How can we approximate integrals with these functions?
- What is the weak formulation? Describe with the example of Poisson equation.
- Describe the procedure of reduction of the Poisson equation to the SLAE using FEM.
- List the properties of the matrix of SLAE, obtained using the FEM.