



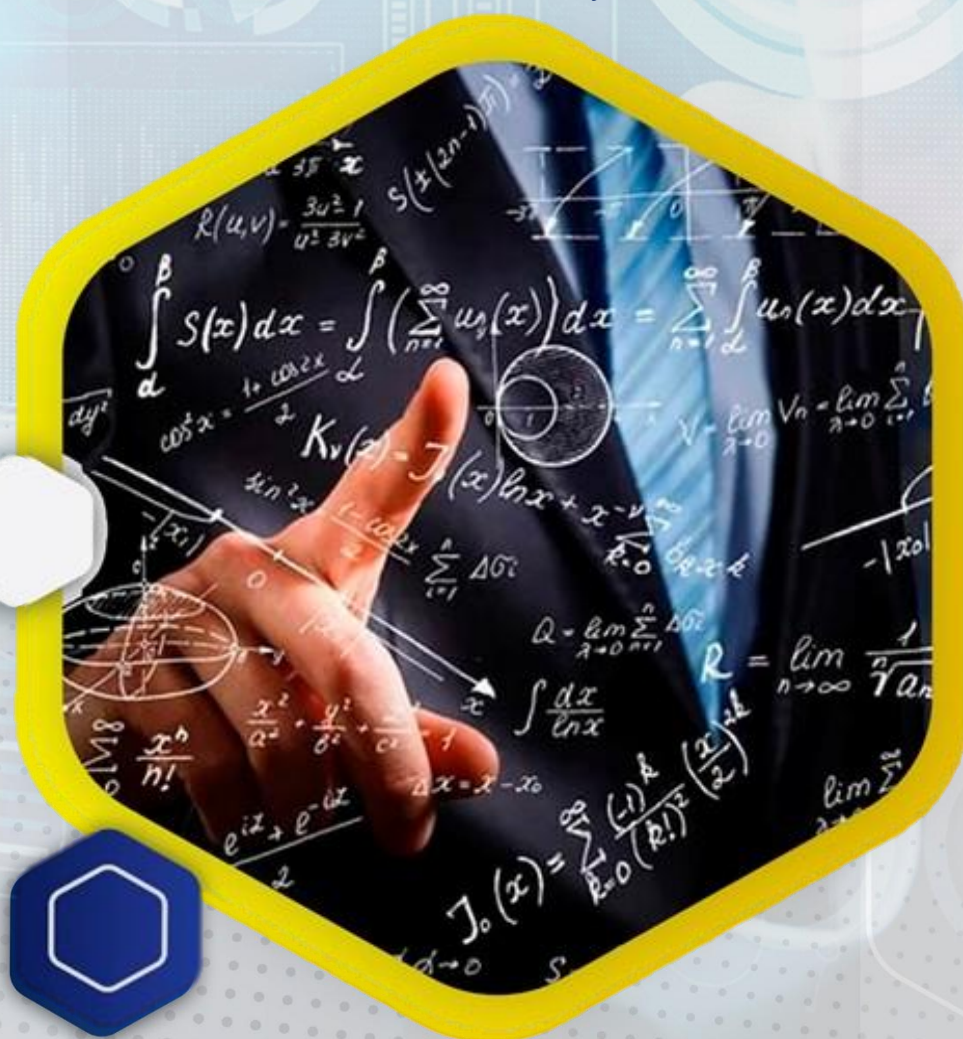
O'ZBEKISTON RESPUBLIKASI
OLIY TA'LIM, FAN VA INNOVATSIYALAR
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BUXORO-2025



**O'ZBEKISTON RESPUBLIKASI
OLIY TA'LIM, FAN VA INNOVATSIYALAR
VAZIRLIGI**



CURRENT PROBLEMS OF PHYSICS, MATHEMATICS AND ARTIFICIAL INTELLIGENCE TECHNOLOGIES

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Abstract. This work considers the problem of interpolation in a Hilbert space, exploring methods for constructing a derivative optimal interpolation formula. It investigates the main properties of Hilbert space and their influence on the interpolation process, as well as the selection of normalized orthogonal bases for the optimal interpolation formula. As a result of the research, optimal coefficients minimizing the norm of the error functional of the interpolation polynomial in Hilbert space are determined. These findings are significant for function approximation, computational mathematics, and numerical analysis.

Keywords: Hilbert space, optimal interpolation formula, error functional, inner product, norm. Let us consider the following Hilbert space:

$$W_2^{(m,m-1)}[0,1] = \{f : [0,1] \rightarrow \mathbb{R} \mid f^{(m-1)}, f^{(m)} \in L_2[0,1]\}$$

where $f^{(r)}$ is the r -th generalized derivative of the function f

The Hilbert space is one of the key concepts in functional analysis. It is an infinite-dimensional, complete vector space. Hilbert spaces are widely used in quantum mechanics, theoretical physics, and other fields of mathematics.

In [2], significant research is presented on constructing and analyzing optimal quadrature formulas in Hilbert space.

In general, interpolation formulas are expressed as follows:

$$L[f] = \sum_{i=1}^n \lambda_i f(x_i) + \sum_{j=1}^k \mu_j f^{(s_j)}(t_j),$$

To construct an optimal interpolation formula, we define the following steps:

An optimal interpolation formula must satisfy the following condition:

$$\|f(x) - Lf\| \rightarrow \min. \quad (3)$$

To construct an optimal interpolation formula, we define the following steps:

1. Define the inner product. In Hilbert space, the scalar product is defined as:

$$(f, g) = \int_a^b f(x)g(x)dx. \quad (4)$$

This allows us to compute the norm:

$$\|f\| = \sqrt{(f, f)}. \quad (5)$$

2. Express the error function. The error (residual) function is given by:

$$R[f] = f(x) - Lf. \quad (6)$$

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