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Студенттер мен жас ғалымдардың
«ҒЫЛЫМ ЖӘНЕ БІЛІМ - 2018»
XIII Халықаралық ғылыми конференциясы

СБОРНИК МАТЕРИАЛОВ

XIII Международная научная конференция студентов и молодых ученых
«НАУКА И ОБРАЗОВАНИЕ - 2018»

The XIII International Scientific Conference for Students and Young Scientists
«SCIENCE AND EDUCATION - 2018»

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The proceedings are the papers of students, undergraduates, doctoral students and young researchers on topical issues of natural and technical sciences and humanities.

В сборник вошли доклады студентов, магистрантов, докторантов и молодых ученых по актуальным вопросам естественно-технических и гуманитарных наук.

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WEIGHTED HARDY TYPE INEQUALITY ON TIME SCALE

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For completeness, before we prove the main results, we recall the following concepts related to the notion of time scales.

A *time scale* T is an arbitrary nonempty closed subset of the real numbers. Thus

$R,\ Z,\ N,\ N_0,$

i.e., the real numbers, the integers, the natural numbers, and the nonnegative integers are examples of time scales, as are

$[0;1],\ [2;3],\ [0,1]\cup N$ and the Cantor set;

while

$Q,\ R\setminus Q,\ (0;\ 1),$

i.e., the rational numbers, the irrational numbers, the complex numbers, and the open interval between 0 and 1, are not *time scales*.

The calculus of time scales was initiated by Stefan Hilger in his PhD thesis [1] in order to create a theory that can unify discrete and continuous analysis. Indeed, below we will introduce the delta derivative f^{Δ} for a function f defined on T, and it turns out that

(i) $f^{\Delta}=f^{'}$ is the usual derivative if $T=R$ and

(ii) $f^{\Delta}=\Delta f$ is the usual forward di_erence operator if $T=Z$.

Let T be a time scale. For $t\in T$ we define the forward jump operator $\sigma:T\to T$ by

$\sigma(t):=\inf\{s\in T; t<s\},$

while the backward jump operator $\rho:T\to T$ is de_ned by

$\rho(t):=\inf\{s\in T; s<t\}.$

If $\sigma(t)>t$, we say that t is right-scattered, while if $\rho(t)<t$ we say that t is left-scattered. If $t<\sup T$ and $\sigma(t)=t$, then t is called right-dense, and if $t>\inf T$ and $\rho(t)=t$, then t is called left-dense. Points that are right-dense and left-dense at the same time are called dense.

Definition 1. Assume $f:T\to R$ is a function and let $t\in T$. Then we define $f^{\Delta}(t)$ to be the number (provided it exists) with the property that given any $\varepsilon>0$, there is a neighborhood U of t (i.e., $U=(t-\delta;t+\delta)$ \ T for some $\delta>0$) such that

$|[f(\sigma(t))-f(s)]-f^{\Delta}(t)[\sigma(t)-s]|<\varepsilon|\sigma(t)-s|.$

We call $f^{\Delta}(t)$ the delta (or Hilger) derivative of f at t.

Definition 2. A function $f:T\to R$ is called regulated provided its right-sided limits exist (finite) at all right-dense points in T and its left-sided limits exist (finite) at all left-dense points in T.

Definition 3. A function $f:T\to R$ is called rd-continuous provided it is continuous at right-dense points in T and its left-sided limits exist (finite) at left-dense points in T.

We define the indefinite integral of a regulated function f by

$\int f(t)\Delta t:=F(t)+C,$

where C is an arbitrary constant and F is a pre-antiderivative of f. We define the Cauchy integral by

$$\int_a^b f(t)\Delta t := F(b) - F(a),$$

for all $a, b \in T$. A function $F: T \to R$ is called an *antiderivative* of $f: T \to R$ provided

$$F^{\Delta}(t) = f(t)$$

holds for all $t \in T$.

Denote $[a;\infty)_{\mathrm{T}} := \{t \in T : t \geq a\}$, where T is a particular time scale, which is unbounded above. For $\forall a \in R$ the set of rd-continuous functions $f:[a;\infty)_{\mathrm{T}} \to R$ will be denoted by $C_{rd}[a;\infty)_{\mathrm{T}}$.

We consider an integral inequality in the following form:

$$\left(\int_a^{\infty} u^q(x)\left(\int_a^x f(t)\Delta t\right)^q \Delta x\right)^{1/q} \leq C\left(\int_a^{\infty} f^p(x)v^p(x)\Delta x\right)^{1/p}, \quad \forall f \in C_{rd}[a;\infty)_{\mathrm{T}}, \qquad (1)$$

where the constant C does not depend on function f, and p; q are fixed parameters and u and v be nonnegative weight functions. If $T = R$, then we get that the well known classical weighted Hardy type inequality was studied by the books [2], [3], [4] and [5].

Our main result reads as follows.

Therome 1. *Let* $1 \leq p \leq q < \infty$ *and* $1/p + 1/p' = 1$. *Then the inequality (1) holds if and only* $B < \infty$ *satisfied, where*

$$B := \sup_{t \in [a;\infty)_{\mathrm{T}}} \left(\int_t^{\infty} u^q(x)\Delta x\right)^{1/q}\left(\int_a^t v^{-p'}(\tau)\Delta\tau\right)^{1/p'} < \infty,$$

Moreover, $B \approx C$, *where* C *is the best constant in (1).*

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TWO-WEIGHTED ESTIMATES FOR RIEMANN-LIOUVILLE INTEGRAL ON TIME SCALE

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Since the discovery of the classical Hardy inequalities (continuous or discrete) much work has been done, and many papers which deal with new proofs, various generalizations and