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 Status Pengusul : penulis ke-3
 Identitas Jurnal Ilmiah : a. Nama Jurnal : Jurnal Matematika (JFMA/Sinta3)
 b. Nomor ISSN : ISSN: [2621-6019](#)/ e-ISSN: [2621-6035](#)
 c. Vol, No., Bln Thn : Vol. 19, No.2, Agustus 2016
 d. Penerbit : Fakultas Sains dan Matematika, Universitas Diponegoro
 e. DOI artikel (jika ada) : -
 f. Alamat web jurnal : [Vol 19, No 2 \(2016\): Jurnal Matematika \(undip.ac.id\)](#)
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Unit Kerja : FSM Undip

Bidang Ilmu: Matematika

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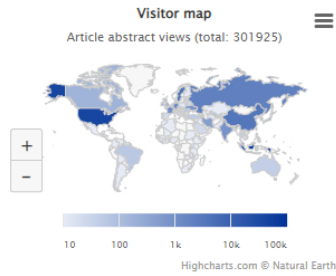
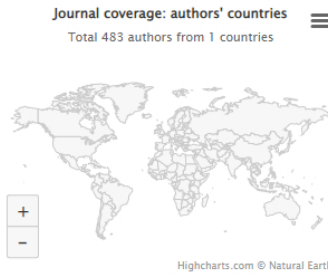
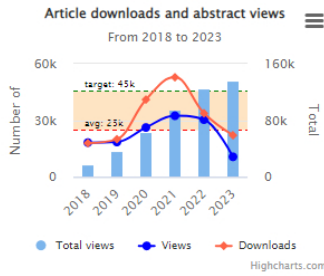
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 JFMA is supported by INDO-MS DIY-JATENG



Editor in Chief
 Prof. Dr. Sunarsih
ISSN online
 2621-6035
ISSN print
 2621-6019
Issues
 2 Issues per year

Journal Profile

Publication schedule: June and November
Language: English, Indonesia (2018-2022)
APC: No publication or submission fee
Accreditation (S3): Indonesian Ministry of Res. Tech. & Higher Edu. (No. 105/E/KPT/2022)
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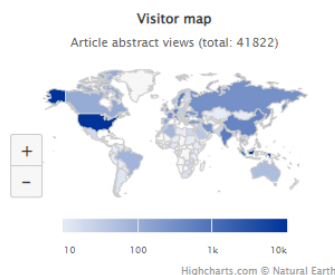
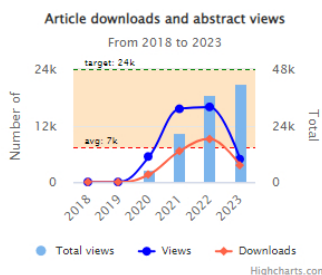
JFMA is supported by the Indonesian Mathematical Society Regional D.I. Yogyakarta-Central Java

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Received: 21 Oct 2016; Published: 21 Oct 2016.

General information

Published: 21-10-2016

Total Articles: 6
(Including Editorial)

Total Authors: 16

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Journal Profile

Publication schedule: June and November
Language: English, Indonesia (2018-2022)
APC: No publication or submission fee
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ROUGH RINGS, ROUGH SUBRINGS, AND ROUGH IDEALS

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Abstract. The basic concept in algebra namely set theory can be expanded into rough set theory. Basic operations on the set such as intersections, unions, differences, and complements still apply to rough sets. In addition, one of the applications on rough sets is the use of rough matrices in decision-making processes. Furthermore, mathematical or informatic researchers who work on rough sets connect the concept of rough sets with algebraic structures (e.g. groups, rings, and modules) so that a concept called rough algebraic structures is obtained. Since the research related to rough sets is mostly carried out at the same time, different concepts have emerged related to rough sets and rough algebraic structures. In this paper, new definitions of the rough ring and rough subring will be given along with related examples and theorems. Furthermore, it will also be defined the left ideal and the right ideal of the rough ring along with examples. Finally, we will discuss the theorem regarding rough ideals.

Keywords: Rough Sets, Rough Rings, Rough Subrings, Rough Ideals

I. INTRODUCTION AND BASIC THEORY

In 1982, Pawlak introduced the notion of rough set [1]. Before we consider the definition of a rough set, we need to consider the definition of approximation space, equivalence relation, lower and upper approximation, and boundary.

Definition 1.1 [1] Suppose U is a universe and non-empty set and β is an equivalence relation on U . The set (U, β) is said to be an approximation space.

Definition 1.2 [1] Suppose U is a universe and β be an equivalence relation on U . We denote the equivalence class of object x in R by $[x]_\beta$.

Definition 1.3 [1] Suppose (U, β) is an approximation space and X is a subset of U . The sets $\overline{X} = \{x | [x]_\beta \cap X \neq \emptyset\}$, $\underline{X} = \{x | [x]_\beta \subseteq X\}$, and $Bnd(X) = \overline{X} - \underline{X}$ are called upper approximation, lower approximation, and boundary of X . In other reference like [2] and [3], the notation of lower and upper approximation are $\underline{Apr}(X)$ and $\overline{Apr}(X)$ respectively.

Definition 1.4 [1] Let U is an approximation space and X is a subset of U . X is called a rough set in (U, β) if and only if $Bnd(X) \neq \emptyset$.

To clarify Definition 1.4, an example will be formed as an explanation of Definition 1.4.

SOME NEW REMARKS ON POWER SUMS

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Abstract. Power sum is one of the interesting topics in number theory where its application in other sciences is known to be wide. This paper intends to stipulate new remarks on an explicit polynomial solution to power sums. Additionally, it investigates the general solution under odd and even numbers of terms and discusses some examples.

Keywords: power sums; explicit polynomial solution; odd and even terms

I. INTRODUCTION

In number theory, a lot of mathematicians are intrigued by finding an explicit solution to power sums [1] [2] [3] [4] [5] [6]. Power sum is a sum of n consecutive natural numbers that is raised to the power of $p \in \mathbb{Z}^+$ [6]. In particular, this can be written as

$$1^p + 2^p + \dots + n^p = \sum_{i=1}^n i^p \quad (1)$$

Now, if the first term of the sequence is arbitrarily chosen to have a power sum of t terms, then it can be written as follows

$$\lambda^p + (\lambda + 1)^p + (\lambda + 2)^p + \dots + (\lambda + t - 1)^p = \sum_{i=\lambda}^{\lambda+t-1} i^p \quad (2)$$

where λ and p are natural numbers. Evidently, there are many mathematical results have been published in the literature that deals with the solution of power sums via different methods [7] [8] [9]. Inspired by the existing and fascinating results, this paper intends to construct a new polynomial solution that solves a power sum explicitly.

In fact, this paper is motivated by the paper of Casinillo [10], whose work is focusing on alternating power sums. Hence, an identical method in [10] was used to obtain some new remarks in finding the solution of power sums. Firstly, we consider the different mathematical forms of power sums adapted from [10]. Here it is. Let λ and p be natural numbers. If $t = 2x - 1$ ($x \in \mathbb{Z}^+$), then

$$S_t^o(\lambda, x, p) = \sum_{j=\lambda}^{\lambda+2x-2} j^p = \lambda^p + (\lambda + 1)^p + \dots + (\lambda + 2x - 2)^p \quad (3)$$

and for $t = 2x$ ($x \in \mathbb{Z}^+$), we have

$$S_t^e(\lambda, x, p) = \sum_{j=\lambda}^{\lambda+2x-1} j^p = \lambda^p + (\lambda + 1)^p + \dots + (\lambda + 2x - 1)^p \quad (4)$$

In this study, the superscripts o and e in the power sum notation above represent an odd and even number of terms of the series, respectively. Next, we need the following notations. First, we let $P_n(x) \in \mathbb{Z}[x]$ be a polynomial in x of degree $n \in \mathbb{Z}^+$. Secondly, we let $f_j(\lambda) \in \mathbb{Z}[\lambda]$ be