AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

Application of Modulo and Zeller Concepts in Determining the Beginning of Ramadan and the Beginning of Shawwal in 1443 H-1447 H

Muhammad Farhan Juliansyah[1*], Hanah Dewi Sajidah[2], Lutfi Wahdani[3], Muji Indah Rahayu Ramadhani[4], Agus Miftakus Surur[5].
[12345]Institut Agama Islam Negeri Kediri
(Jl. Sunan Ampel, No. 7, Kel. Ngronggo, Kec. Kota Kediri, Kota Kediri, Jawa Timur Kode Pos 64127)
[*]Email: gohanasoy@gmail.com

Abstract

This study aims to calculate the estimate of when the beginning of the month of Ramadan and the month of Shawwal. In addition, it is also used to find out whether there are differences and similarities when determining the beginning of the month of Ramadan and the month of Shawwal using the mathematical concept of modulo 7 and Zeller's congruence. This research is a qualitative research with a literature study approach to investigate scientific literature related to the concept of modulo and Islamic calendar calculation methods. This research focuses on the concept of modulo in determining the beginning of Ramadan and Shawwal. The results of this study indicate that using the calculation of Zeller's congruence is more precise or closer than using the calculation of the modulo 7 concept seen from the 1443 H-1447 H calendar. This research provides an important contribution in understanding the calculation of the Islamic calendar, especially in determining the beginning of Ramadan and Shawwal with the mathematical concepts used such as modulo.

Keywords: ***Modulo concept, Beginning of Ramadan, Beginning of Shawwal***

Article Info
Received:
03 Desember 2023
Revised:
03 Mei 2024
Accepted:
20 Juni 2024
Published:
29 Juni 2024

A. Introduction

The determination of the beginning of the Islamic months is often a source of debate and controversy among the Muslim community. Some people prefer to follow mathematical calculations, while others prefer direct observation methods. This can lead to inequalities in date setting in different places.[1] As is the case in Indonesia, there are often differences of opinion in determining the start of Ramadan, as determining the date is not easy, especially in Indonesia, which consists of many islands with three different time zones. In Indonesia, there are two methods commonly used to determine the beginning of Ramadan: ru'yatul hilal and hisab.[2] In determining the beginning of the Hijri month, mathematics and astronomy play a very important role. Since ancient times, Muslims have used astronomical calculations to identify the beginning of the Hijri month, which is the basis of the calendar used by Muslims to determine important dates such as the beginning of Ramadan and Shawwal. Today, the calendar has many additional functions beyond simply marking historical days.[3] There are

ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

various mathematical approaches used by Muslim communities around the world to determine the beginning of Ramadan and Shawwal. These include astronomical calculation methods and calculation methods based on hilal (crescent moon) observations.[4]

In determining the beginning of Ramadan, mathematics and astronomy play a very important role. Since ancient times, Muslims have successfully used astronomical calculations to determine the beginning of Ramadan, which is the calendar used by Muslims to determine important dates such as the beginning of the Hijri month and Eid al-Fitr. While today the calendar has many functions in addition to marking historical days, the calendar also has benefits as a reminder for us as humans who can be reminded by the calendar if humans will do something. Determining the beginning of the month of Ramadan is an issue that is most often debated, where the determination of the beginning of the month of Ramadan is a day that has a momentum of joy to go to victory in the month of Fitri. However, some Muslims feel haunted by differences when looking at the phenomenon of determining the beginning of the month of Ramadan. In the research that has been done that in determining the beginning of the month of Ramadan can use astronomical theory, rukyatul hilal, and hisab. In this study, to determine the beginning of the month of December can be associated with using concepts in mathematics, which is precisely associated with number theory material, precisely the modulo system. One of the uses of modulo can be applied to determine the beginning of the month of Ramadan in each year. Both from last year and the year to come provided that the date, month, and year to be searched must be known with certainty. The concept of modulo 7 can be used to see the days in the Hijri calendar. We often experience incidents to determine 1 Ramadan or other religious holidays that are difficult for us to remember correctly. Calendar making cannot be separated from mathematics, including in predicting the days of these religious holidays in the next few years. Some previous studies whose research is related to the research to be carried out are Agung Handayanto [1] who explains the Role of the Modulo System in Determining Days and Markets, then Zuli Nuraeni [2] who discusses the Application of Number Theory in the Calculation of the National Calendar. From some of these studies, the following will be presented some easy ways to predict the upcoming religious holidays by being associated in mathematics, namely modulo material.

The use of hisab in the Hijri calendar can be replaced with the Zeller congruence system. With Zeller's congruence system, we can also determine important days in the Islamic

ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

calendar such as the beginning of Ramadan. Zeller's congruence, discovered by Julius Christian Johannes Zeller, has been applied in the determination of the Gregorian and Julian calendars. With this equation, it is also possible to estimate the day of a date in the lunar calendar. Zeller's equation is one of the calculations that uses the basic theory of modulo arithmetic. The modulo system is an important part of number theory. Number theory has been the basis for the development of several branches of mathematics such as cryptography and computer science. One of the interesting benefits of the modulo system in everyday life is determining the day without having to open an almanac. By applying the modulo system in number theory, we can determine the day of the previous year or the coming year.

In determining the date of the beginning of the month of Ramadan and the beginning of the month of Shawwal in the year 1443-1447 Hijriyah, in addition to being determined by using the Hisab calculation method and Hilal Observation, this research will be associated with mathematical concepts, namely by paying attention to calculations on the concept of Modulo 7 and Zeller's Kesebangunan. The selection of these mathematical concepts, because there has been no previous research that uses the mathematical concepts of Modulo 7 and Zeller's Kesebangunan to calculate the estimation of the beginning of the month of Ramadan and Shawwal. In addition, it is also used to determine whether there are differences and similarities when determining the beginning of the month of Ramadan and Shawwal by using the mathematical concepts of Modulo 7 and Modulo Zeller. Based on the background and research objectives that have been described, the author will conduct research "Application of the Modulo Concept in Determining the Beginning of Ramadan and the Beginning of Shawwal in 1443-1447 H".

B. Method

This research uses a qualitative method with a literature study approach. Bogdan and Taylor (1982) state that qualitative research is a research procedure that produces descriptive data in the form of written or spoken words from people and observable behaviour, the approach is directed at holistic settings and individuals. Then for literature study is an activity related to library data collection methods, reading, recording, and processing research materials that are useful for completing scientific work (Zed, 2008). The data sources used to conduct this research are journal articles, and several books and documents needed in writing the article. The research technique used in this research is

AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

that researchers look for accredited journal articles, and books related to the title and support the discussion. The books and journal articles obtained were then read and understood to find conclusions from previous research articles. The procedure in collecting this data was carried out by searching for journal articles on Google Scholar and the Sinta journal platform with more than 10 articles and looking for books relevant to the research title. The data analysis method used in this research is the content analysis method and secondary data analysis, namely by utilising secondary sources and then concluding in order to obtain the data needed in writing this article.

C. Results and Discussion

Research Results

Modulo is an operation that produces the remainder of division of a number by another number.[5] The definition of congruence is two flat shapes that have the same shape and size.[6] In this case, congruence is denoted by using the symbol (≡).

Estimating the Beginning of Ramadan and the Beginning of Shawwal with the Mathematical Concept of Equivalence and Modulo 7.

As for determining the beginning of the month of Ramadan and the beginning of the month of Shawwal using the mathematical concepts of Modulo and Congruence, to obtain an estimate of the exact date, this discussion will introduce the modulo 7 system which has an important role in determining the beginning of the month of Ramadan and the beginning of the month of Shawwal. This modulo system uses seven numbers, namely 0, 1, 2, 3, 4, 5, and 6. Addition in the modulo 7 system is the same as ordinary addition, except that if the sum is greater than 6, then we divide the sum by 7 and use the remainder instead of ordinary addition. So, 5+1=6, but 14+2=2 because if 16 is divided by 7, the remainder is 2. Here is a table with the modulo system sums.

Table 1. Modulo 7 Concept

+	0	1	2	3	4	5	6
0	0	1	2	3	4	5	6
1	1	2	3	4	5	6	0
2	2	3	4	5	6	0	1
3	3	4	5	6	0	1	2
4	4	5	6	0	1	2	3
5	5	6	0	1	2	3	4

ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

6	6	0	1	2	3	4	5

With the set H = {Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday}. Using three key notions:

1. Modulo 7 system
2. Ordinary Year = 354 Days
3. Leap Year = 355 days (year whose number is divisible by four) 3.

The formula that can be used to find the days of the desired date, month, and year will then be obtained. In fact, the number of all days in the Hijri Calendar starting from the 1st of Muharram year 1 up to the date x month y year z that will be sought for the day, calculated then later the result will be divided by 7. From some experiments that the researcher will later describe, it turns out that if the remainder is zero it will fall on Saturday, and if the remainder is 1 it will fall on Sunday and so on finally if the remainder is 6 on Friday as shown in the following table:

Table 2. Remaining Days

Remaining	Days
0	Saturday
1	Sunday
2	Monday
3	Tuesday
4	Wednesday
5	Thursday
6	Friday

It can be seen that the number of days in a normal year = 354 days, which means that 354 = 4 (modulus 7), while the number of days in a leap year is 355 days, which means that 355 = 5 (modulus 7). We can suppose that D year = E ordinary year + F leap year. The number of days divided by 7, let us suppose: D=E+2F=G=7H+I, where H: the natural number resulting from dividing G by 7. I: the remainder of the division, thus D years = I days (modulus 7). From some of the above explanations that will be used to determine a particular day can be used in the following ways:

Using the formula: B+D+E=R (modulus 7)

Notes:

- B = T±1 (T is the number of years)

AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

- D = the largest integer of (V/4)

- E = the number of days from the 1st of Muharram to the date to be found

-R = remainder of division modulo 7

Table 3. Number of Days per Month

Month Names	Ordinary or Leap Year
Muharram	30
Safar	29
Rabiul Awal	30
Rabiul Akhir	29
Jumadil Awal	30
Jumadil Akhir	29
Rajab	29
Sya'ban	30
Ramadhan	30
Syawal	29
Zulqodah	30
Zulhijjah	29 or 30

From the help of the table, it will be determined the beginning of the month of Ramadan and the beginning of the month of Shawwal in 1443 H - 1447 H will be exactly on what day?

Determination of the beginning of the month of Ramadan in 1443 H - 1447 H using the mathematical concept of Modulo 7.

The beginning of Ramadan in 1443 H

B = 1443- 1 = 1442

D = 1443/4 = 360.75 = 361

E = (beginning of Muharram until the beginning of Ramadan) = 237

Thus, we get B + D + E = 1442 + 361 + 237 = 2040 = 3 (mod 7)

Because R = 3, so based on Table 2, the beginning of Ramadan in 1443 H falls on Tuesday.

The beginning of Ramadan in 1444 H

B = 1444 - 1 = 1443

D = 1443/4 = 360.75 = 361

E = (the beginning of Muharram to the beginning of Ramadan) = 237

Thus, we get B + D + E = 1443 + 361 + 237 = 2041 = 4 (mod 7)

AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

Because R = 4, so based on Table 2, the beginning of Ramadan in 1443 H falls on Wednesday.

The beginning of Ramadan in 1445 H

B = 1445 - 1 = 1444

D = 1444/4 = 361

E = (the beginning of Muharram to the beginning of Ramadan) = 237

Thus, we get B + D + E = 1444 + 361 + 237 = 2042 = 4 (mod 7)

Since R = 5, so based on Table 2, the beginning of Ramadan in 1445 H falls on Thursday.

The beginning of Ramadan in 1446 H

B = 1446 - 1 = 1445

D = 1445/4 = 361, 25 - 361

E = (the beginning of Muharram to the beginning of Ramadan) = 237

Thus, we get B + D + E = 1445 + 361 + 237 = 2043 = 6 (mod 7)

Because R = 6, so based on Table 2, the beginning of Ramadan in 1446 H falls on Friday.

The beginning of Ramadan in 1447 H

B = 1447 - 1 = 1446

D = 1446/4 = 361,5 = 362

E = (beginning of Muharram to the beginning of Ramadan) = 237

Thus, we get B + D + E = 1446 + 362 + 237 = 2045 = 1 (mod 7)

Because R = 1, so based on Table 2, the beginning of Ramadan in 1447 H falls on Sunday.

Determination of the beginning of Shawwal in 1443 H - 1447 H by using the mathematical concept of Modulo 7

Using the formula: B+D+E=R (modulus 7)

Description:

B = T±1 (T is the number of years)

D = the largest integer of (V/4)

E = the number of days from the 1st of Muharram to the date to be found

R = remainder of division modulo 7

ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

The beginning of Shawwal in 1443 H

B = 1443 - 1 = 1442

D = 1442/4 = 360, 5 = 361

E = (beginning of Muharram to the beginning of Shawwal) = 267

Thus, we get B + D + E = 1442 + 361 + 267 = 2070 = 5 (mod 7)

Since R = 5, so based on Table 2, the beginning of Shawwal in 1443 H falls on Thursday.

The beginning of Shawwal in 1444 H

B = 1444 - 1 = 1443

D = 1443/4 = 360.75 = 361

E = (beginning of Muharram to the beginning of Shawwal) = 267

Thus, we get B + D + E = 1443 + 361 + 267 = 2071 = 6 (mod 7)

Because R = 6, so based on Table 2, the beginning of Shawwal in 1444 H falls on Friday.

The beginning of Shawwal in 1445 H

B = 1445 - 1 = 1444

D = 1444/4 = 361

E = (beginning of Muharram to the beginning of Shawwal) = 267

Thus, we get B + D + E = 1444 + 361 + 267 = 2072 = 0 (mod 7)

Because R = 0, so based on Table 2, the beginning of Shawwal Year 1445 H falls on Monday.

The beginning of Shawwal in 1446 H

B = 1446 - 1 = 1445

D = 1445/4 = 361,25 = 361

E = (beginning of Muharram to the beginning of Shawwal) = 267

Thus, we get B + D + E = 1445 + 361 + 267 = 2073 = 1 (mod 7)

Since R = 1, so based on Table 2, the beginning of Shawwal in 1446 AH falls on Sunday.

The beginning of Shawwal in 1447 H

B = 1447 - 1 = 1446

AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

D = 1446/4 = 361,5 = 362

E = (beginning of Muharram to the beginning of Shawwal) = 267

Thus, we get B + D + E = 1446 + 362 + 267 = 2075 = 3 (mod 7)

Since R = 3, so based on Table 2, the beginning of Shawwal in 1447 H falls on Tuesday.

Estimating the beginning of Ramadan and the beginning of Shawwal using the concept of Zeller's Congruence

Zeller's congruence is an equation discovered by Julius Christian Johannes Zeller, a German priest and mathematician. The equation was found to be applied in determining the Gregorian calendar. But it turns out that Zeller's congruence can also be applied in determining the days or the beginning of the month on the lunar calendar.

The formula in determining the day in the Hijri calendar which is a modification of the Gregorian calendar is:

$$h = (d + \left[\frac{3m}{2}\right] + 4Y + 4\left[\frac{Y}{30}\right] + k_Y)\ mod\ 7$$

Description:

- h is the day of the week
- d is the date for which you want to find the day
- m is the month whose day is to be found (1 = Muharram, 2 = Safar, ... , 12 = Dhulhjjah) y is the year of the date in question
- is the value that states the number of leap years

To determine the leap year that passes in a period of thirty years can be determined by the remaining division of the year Y by 30. The value of ky used to express the leap year is contained in the following table because the calculation to determine the leap year is quite difficult.

Table 4. Leap Year

Nilai $r = Y\ mod\ 30$	Nilai k_Y
$r \leq 2$	0
$2 < r \leq 5$	1
$5 < r \leq 7$	2
$7 < r \leq 10$	3
$10 < r \leq 13$	4
$13 < r \leq 15$ (Basis-15)	5
$13 < r \leq 16$ (Basis-16)	
$15 < r \leq 18$ (Basis-15)	6

AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

$16 < r \leq 18$ (Basis-16)	
$18 < r \leq 21$	7
$21 < r \leq 24$	8
$24 < r \leq 26$	9
$26 < r \leq 29$	10

To determine the day of the calculation results can use the same rules as determining the rest of the day on the concept of modulo 7. So it can be seen in table 2 discussion of the concept of modulo 7.

Determination of the beginning of the month of Ramadan in 1443 H - 1447 H by using the mathematical concept of Zeller's congruence

Determination of the beginning of Ramadan in 1443 with Zeller's congruence

$d = 1, m = 9, Y = 1443$

$r = 1443 \ mod \ 30$

$r = 3$, then $k_Y = 1$

$$h = (1 + \left[\frac{3(9)}{2}\right] + 4(1443) + 4\left[\frac{1443}{30}\right] + 1) \ mod \ 7$$

$h = 5979 \ mod \ 7$

$h = 1$

Because, so based on Table 2, the beginning of Ramadan in 1443 H falls on Sunday.

Determination of the beginning of Ramadan in 1444 H with zeller congruence

$d = 1, m = 9, Y = 1444$

$r = 1444 \ mod \ 30$

$r = 4$, then $k_Y = 1$

$$h = (1 + \left[\frac{3(9)}{2}\right] + 4(1444) + 4\left[\frac{1444}{30}\right] + 1) \ mod \ 7$$

$h = 5984 \ mod \ 7$

$h = 6$

Because, so based on Table 2, the beginning of Ramadan 1444 H falls on Friday.

Determination of the beginning of Ramadan in 1445 H with zeller congruence

$d = 1, m = 9, Y = 1445$

$r = 1445 \ mod \ 30$

$r = 5$, then $k_Y = 1$

ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

$$h = (1 + \left[\frac{3(9)}{2}\right] + 4(1445) + 4\left[\frac{1445}{30}\right] + 1)\ mod\ 7$$

$$h = 5988\ mod\ 7$$

$$h = 3$$

Because, so based on Table 2, the beginning of Ramadan 1445 H falls on Tuesday.

Determination of the beginning of Ramadan in 1446 H with zeller congruence

$d = 1, m = 9, Y = 1446$

$r = 1446\ mod\ 30$

$r = 6$, then $k_Y = 2$

$$h = (1 + \left[\frac{3(9)}{2}\right] + 4(1446) + 4\left[\frac{1446}{30}\right] + 2)\ mod\ 7$$

$$h = 5993\ mod\ 7$$

$$h = 3$$

Because, so based on Table 2, the beginning of Ramadan 1446 H falls on Sunday.

Determination of the beginning of Ramadan in 1447 H with zeller congruence

$d = 1, m = 9, Y = 1447$

$r = 1447\ mod\ 30$

$r = 7$, then $k_Y = 2$

$$h = (1 + \left[\frac{3(9)}{2}\right] + 4(1447) + 4\left[\frac{1447}{30}\right] + 2)\ mod\ 7$$

$$h = 5997\ mod\ 7$$

$$h = 5$$

Because, so based on Table 2, the beginning of Ramadan in 1447 H falls on Thursday.

Determination of the beginning of Shawwal in 1443 H - 1447 H using the mathematical concept of Zeller's Congruence.

Determination of the beginning of Shawwal in 1443 H with zeller's congruence

$d = 1, m = 10, Y = 1443$

$r = 1443\ mod\ 30$

$r = 3$, then $k_Y = 1$

$$h = (1 + \left[\frac{3(10)}{2}\right] + 4(1443) + 4\left[\frac{1443}{30}\right] + 1) mod\ 7$$

$$h = 5981\ mod\ 7$$

AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

$h = 3$

Because, so based on Table 2, the beginning of Shawwal in 1443 H falls on Tuesday.

Determination of the beginning of Shawwal in 1444 H with zeller congruence

$d = 1, m = 10, Y = 1444$

$r = 1444 \ mod \ 30$

$r = 4$, then $k_Y = 1$

$$h = (1 + \left[\frac{3(10)}{2}\right] + 4(1444) + 4\left[\frac{1444}{30}\right] + 1) mod \ 7$$

$h = 5985 \ mod \ 7$

$h = 0$

Because, so based on Table 2, the beginning of Shawwal 1444 H falls on Saturday.

Determination of the beginning of Shawwal in 1445 H with zeller congruence

$d = 1, m = 10, Y = 1445$

$r = 1445 \ mod \ 30$

$r = 5$, then $k_Y = 1$

$$h = (1 + \left[\frac{3(10)}{2}\right] + 4(1445) + 4\left[\frac{1445}{30}\right] + 1) mod \ 7$$

$h = 5989 \ mod \ 7$

$h = 4$

Because, so based on Table 2, the beginning of Shawwal in 1445 H falls on Wednesday.

Determination of the beginning of Shawwal in 1446 H with zeller congruence

$d = 1, m = 10, Y = 1446$

$r = 1446 \ mod \ 30$

$r = 6$, then $k_Y = 2$

$$h = (1 + \left[\frac{3(10)}{2}\right] + 4(1446) + 4\left[\frac{1446}{30}\right] + 2) mod \ 7$$

$h = 5994 \ mod \ 7$

$h = 2$

Because, so based on Table 2, the beginning of Shawwal in 1446 H falls on Monday.

Determination of the beginning of Shawwal in 1447 H with zeller congruence

$d = 1, m = 10, Y = 1447$

$r = 1447 \ mod \ 30$

AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

$r = 7$, then $k_Y = 2$

$$h = (1 + \left[\frac{3(10)}{2}\right] + 4(1447) + 4\left[\frac{1447}{30}\right] + 2) mod\ 7$$

$$h = 5998\ mod\ 7$$

$$h = 6$$

Because, so based on Table 2, the beginning of Shawwal 1447 H falls on Friday.

Discussions

In 1443 AH according to the calculation with hisab modulo 7 the beginning of Ramadan fell on Tuesday, while according to the calculation with Zeller's hisab the beginning of Ramadan fell on Sunday and after being traced the calculation with Zeller's hisab was right with the occurrence of the beginning of Ramadan in Indonesia. Furthermore, in 1444 AH the beginning of Ramadan fell on Wednesday according to the calculation with modulo 7 and Friday according to Zeller's congruence, while in Indonesia the beginning of Ramadan in that year fell on Thursday. In these two years, the calculation in accordance with the beginning of Ramadan in Indonesia is in 1443 using Zeller's hisab while other calculations are not appropriate or backward one or two days. This is because the calculation of the beginning of Ramadan used by the government in Indonesia is the Ru'yatul Hilal method (observation of hilal / new crescent moon) after sunset.

The beginning of Ramadan in 1445 H is Thursday according to the calculation with modulo 7 and Tuesday with the calculation of Zeller's hisab. Then after being matched with the calculations used in the NU Online calendar, the beginning of Ramadan fell on Tuesday. Then in 1446 H based on calculations with modulo 7 the beginning of Ramadan falls on Friday, while based on Zeller's congruence it falls on Sunday which after being matched is in accordance with the calculation of the NU Online calendar. Furthermore, in 1447 where with the calculation of modulo 7 the beginning of Ramadan falls on Sunday, while with Zeller's hisab the beginning of Ramadan falls on Thursday, this is in accordance with the calculation of NU Online which estimates the beginning of Ramadan also falls on Thursday. In these three years, it cannot be ascertained the suitability between calculations with modulo 7, Zeller congruence calculations, NU

ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v10i1.17541 || Vol. 10, No. 1 Juni 2024

Online calendar calculations with the beginning of Ramadan in Indonesia because these three years have not passed while in Indonesia the government usually uses the Ru'yatul Hilal method which is carried out at maghrib before the beginning of Ramadan each year. Similarly, with Shawwal 1443-1447 Hijriyah, in the calculation using the hisab modulo 7 method and Zeller's equilibrium there are still some that are not in harmony with the events that occur. This means that this method cannot be used as the main method in determining the beginning of Shawwal and the beginning of Ramadan.

D. Conclusion

The concept of modulo 7 is one method or calculation that can be used to see the day in the lunar calendar and often in determining 1 Ramadan or other religious holidays. The other method is the calculation of Zeller's congruence with the calculation of the basic theory of Arithmetic modulo.

In this paper, it states that using the calculation of Zeller's congruence is more precise or closer than using the calculation of the concept of modulo 7 seen from the 1443-1447 H calendar.

E. Suggestion

With the same topic as this research, further research can be carried out with the focus of different mathematical concepts and by examining more deeply the calculations in determining other Islamic holidays.

References

[1] T. Bawazir, *Top 10 Masalah Islam Kontemporer* (Jakarta: Pustaka al-Kautsar, 2019).

[2] Z. Zurhaq, SIlviani, and M. Mukhlis, 'Prediksi Awal Ramadhan Menggunakan Metode Fuzzy Tsukamoto', *ARITMATIKA: Jurnal Riset Pendidikan Matematika*, 1.2, 2020, pp. 88–95

[3] Ahmad Fauzan and others, 'PENETAPAN AWAL BULAN HIJRIYAH DAN INTEGRASINYA DENGAN PERHITUNGAN MATEMATIKA', *Jurnal Religion: Jurnal Agama, Sosial, Dan Budaya*, 1.1, 2023 <https://maryamsejahtera.com/index.php/Religion/index>.

[4] Ridwan, *Kontestasi Mazhab Hisab Dan Rukyat Di Indonesia* (Pustaka Ilmu, 2022)

[5] Sripatmi, Arjudin, and Dwi Novitasari, *Aljabar Abstrak* (P4I, 2022).

[6] C. E. Nasryah and A. A. Rahman, *Ethnomathemathics (Matematika Dalam Perspektif Budaya)* (Ponorogo: Uwais Inspirasi Indonesia, 2020).