

When is Easter?

Easter is an annual festival observed throughout the Christian world and commemorates the Resurrection of Jesus. The rules that determine the date of Easter trace back to the First Council of Nicaea in AD 325. Easter is celebrated on the first Sunday after the Full Moon that occurs on or next after 21 and is therefore celebrated between March 22 and April 25.

Here is an algorithm for determining the date of Easter that I found in an Algebra book in the 1960's. I used this as a computer programming assignment after my students studied the mod operator. On the left-hand side is the general algorithm and on the right-hand side is the calculation for the year 2010.

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| 1. | $\frac{\text{Year}}{19} = R, \text{ remainder } A$ | 1. | $\frac{2010}{19} = 105, \text{ remainder } 15$ |
| 2. | $\frac{\text{Year}}{100} = B, \text{ remainder } C$ | 2. | $\frac{2010}{100} = 20, \text{ remainder } 10$ |
| 3. | $\frac{B}{4} = D, \text{ remainder } E$ | 3. | $\frac{20}{4} = 5, \text{ remainder } 0$ |
| 4. | $\frac{B+8}{25} = F, \text{ omit remainder}$ | 4. | $\frac{20+8}{25} = 1$ |
| 5. | $\frac{B+1-F}{3} = G, \text{ omit remainder}$ | 5. | $\frac{20+1-1}{3} = 6$ |
| 6. | $\frac{19A+B+15-D-G}{30} = \text{omit}, \text{ remainder } H$ | 6. | $\frac{2019}{30} = 67, \text{ remainder } 9$ |
| 7. | $\frac{C}{4} = J, \text{ remainder } K$ | 7. | $\frac{10}{4} = 2, \text{ remainder } 2$ |
| 8. | $\frac{2E+2J+32-H-K}{7} = \text{omit}, \text{ remainder } M$ | 8. | $\frac{25}{7} = 3, \text{ remainder } 4$ |
| 9. | $\frac{A+11H+22M}{451} = N, \text{ omit remainder}$ | 9. | $\frac{202}{451} = 0$ |
| 10. | $\frac{H+M+114-7N}{31} = P, \text{ remainder } Q$ | 10. | $\frac{127}{31} = 4, \text{ remainder } 3$ |
| 11. | MONTH = P and DAY = $Q + 1$ | 11. | MONTH = 4 and DAY = 4 |

Integer division is used in the algorithm on the preceding page (integer division is the way we were first taught to divide; in math, these are called the Greatest Integer Function and the Modulus operator). For example, 6 divided by 4 equals 1 with a remainder of 2 (6 DIV 4 = 1 and 6 MOD 4 = 2).

A similar algorithm was derived by J.M. Oudin in 1940:
His algorithm uses the year, y, to give the month, m, and day, d, of Easter. The symbol * means multiply.

Please note the following: This is an integer calculation. All variables are integers and all remainders from division are dropped. For example, 7 divided by 3 is equal to 2 in integer arithmetic.

$$\begin{aligned}
 c &= y / 100 \\
 n &= y - 19 * (y / 19) \\
 k &= (c - 17) / 25 \\
 i &= c - c / 4 - (c - k) / 3 + 19 * n + 15 \\
 i &= i - 30 * (i / 30) \\
 i &= i - (i / 28) * (1 - (i / 28)) * (29 / (i + 1)) \\
 &\quad * ((21 - n) / 11) \\
 j &= y + y / 4 + i + 2 - c + c / 4 \\
 j &= j - 7 * (j / 7) \\
 l &= i - j \\
 m &= 3 + (1 + 40) / 44 \\
 d &= 1 + 28 - 31 * (m / 4)
 \end{aligned}$$

The following are dates of Easter from 1980 to 2024 (found in many Church hymnals):

1980 April 6	1995 April 16	2010 April 4
1981 April 19	1996 April 7	2011 April 24
1982 April 11	1997 March 30	2012 April 8
1983 April 3	1998 April 12	2013 March 31
1984 April 22	1999 April 4	2014 April 20
1985 April 7	2000 April 23	2015 April 5
1986 March 30	2001 April 15	2016 March 27
1987 April 19	2002 March 31	2017 April 16
1988 April 3	2003 April 20	2018 April 1
1989 March 26	2004 April 11	2019 April 21
1990 April 15	2005 March 27	2020 April 12
1991 March 31	2006 April 16	2021 April 4
1992 April 19	2007 April 8	2022 April 17
1993 April 11	2008 March 23	2023 April 9
1994 April 3	2009 April 12	2024 March 31