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JULIAN DAY NUMBER FOR A GIVEN DATE

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Abstract

An algorithm is described for deriving the Julian Day number for a given calendar date.

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In 1583 the French classical scholar Joseph Scaliger developed a system of chronological reckoning which earned him the title of The Father of Chronological Science. It was devised by Scaliger in the hope of drawing together all the major chronologies of the world. The system was to serve as a medium for the translation from one calendar to another. For this purpose it is well designed, for the Julian Date is essentially a continuous count of days beginning at a point so far back in time that every date in recorded history can be included. This remote date is January 1, 4713 B.C. It is the starting date of the Julian period, a cycle of 7,980 years. Each day in this great cycle has its own Julian Day number. However, since the system functions independently of any particular calendar and covers such an enormous span of time, a problem arises in knowing the Julian Day number of a given date in the calendar.

An ephemeris usually supplies a table of dates with their respective Julian Day numbers. An observer, however, need not depend on such a table. The conversion of calendar dates to Julian Day numbers can be accomplished arithmetically in a three-part iterative algorithm. The algorithm shown below computes the Julian Day number at Greenwich Mean Noon for a given date from January 1, 4713 B.C., onward.

Index:

If date is B.C., Jan. 1, 4713 B.C. to Dec. 31, 1 B.C. inclusive, use mode 1. If date is later than Jan. 1, 1 A.D. to Oct. 4, 1582 A.D. inclusive, use mode 2. If date is later than Oct. 15, 1582 A.D., use mode 3.

Mode 1:

Step 1) 4713 - Y = A
2) A x 365.25 = B
3) B + 0.75 = C
4) C - dec. = D
5) d - 1 = E
6) E + D = JDN

Mode 2:

Step 1) Y - 1 = A
2) A + 4713 = B
3) B x 365.25 = C
4) C + 0.75 = D
5) D - dec. = E
6) d - 1 = F
7) F + E = JDN

Mode 3:

Step 1) Y - 1 = A

2) A + 4713 = B

3) B x 365.25 = C

4) C + 0.75 = D

5) D - dec. = E

6) E - 10 = F

7) P - 16 = G, if P = 15, set G = 0.

8) G ÷ 4 ; r,q   q = H

9) G - H = I, if U = 00 and r = 1, 2, or 3, sub. 1 from I

10) F - I = J

11) d - 1 = K

12) K + J = JDN

Definitions:

Y = year

dec. = decimal remainder

d = number of day in year (e.g., for Feb. 14, d = 45), see text below

P = penultimate digit-pair of year (e.g., for 1980, P = 19)

U = ultimate digit-pair of year (e.g., for 1980, U = 80)

r = remainder

q = quotient

JDN = Julian Day number

The index is not missing any dates. Note that there is no year 0 in civil chronology; December 31, 1 B.C. is immediately followed by January 1, 1 A.D. Also, ten days were removed from the calendar by order of Pope Gregory XIII in 1582. The days between October 4 and October 15, 1582, were eliminated. The calendar in use before 1582 was defective, having gained extra days which were removed upon the inception of the modern calendar.

It is important to note that the algorithm is consistent with the historical development of the calendar. The algorithm yields the Julian Day numbers of dates in the Old Style Julian calendar on or prior to October 4, 1582, A.D. and the Julian Day numbers of dates in the New Style Gregorian calendar on or after October 15, 1582 A.D.

In the algorithm it is necessary to know d. This can be found quickly by adding the day of the month (z) to a value (v) for each month in the year. v = 0 Jan., 31 Feb., 59 Mar., 90 Apr., 120 May, 151 Jun., 181 Jul., 212 Aug., 243 Sep., 273 Oct., 304 Nov., and 334 Dec.. In a leap year all the values of v after February must be raised by one.

e.g., Oct. 23, 1980 (1980 is a leap year)

z = 23
v = 273
d = (v + 1) + z
d = 297

The use of the algorithm is best shown by example: What is the Julian Day number (at Greenwich Mean Noon) for April 11, 1985? First we determine what mode of the algorithm to use. Consulting the Index, we see that April 11, 1985 A.D., is included in the limits set for Mode 3. We go to Mode 3 and proceed as follows:

Step 1) 1985 - 1 = 1984 = A

2) 1984 + 4713 = 6697 = B

3) 6697 x 365.25 = 2446079.25 = C

4) 2446079.25 + 0.75 = 2446080.00 = D

5) 2446080.00 - .00 = 2446080 = E

6) 2446080 - 10 = 2446070 = F

7) 19 - 16 = 3 = G

8) 3 ÷ 4 ; r = 3, q = 0 = H

9) 3 - 0 = 3 = I

10) 2446070 - 3 = 2446067 = J

11) 101 - 1 = 100 = K — for Apr. 11, z = 11, v = 90
d = z + v
d = 11 + 90
d = 101

12) 100 + 2446067 = <u>2446167</u> = JDN

The Julian Day number for April 11, 1985 A.D., is 2,446,167.

The algorithm encompasses the entire Julian Day System. It yields the Julian Day number for any date beginning with the initial date of the Julian Period. In fact, the algorithm covers a wider range of dates than is supplied by the Table of Julian Days in the <u>American Ephemeris and Nautical Almanac</u>.