

# CALENDAR ALGORITHMS

There are several well known algorithms used for determining the day of the week for any date. The calendar programs included here are based on the following:

$$DOW = \left[ \text{INT} \left( \frac{XY}{12} \right) + R + \text{INT} \left( \frac{R}{4} \right) + M + D + \left( 6 - 2 \left( \sqrt{AB} \right) \right) \right]$$

where: DOW = day of week  
 INT = the integral value of  
 R = the remainder after the indicated division  
 D = the day of the month  
 XY = the last two digits of the year  
 AB = the first two digits of the year  
 7 = modulus of the enclosed modular sum  
 (means the same as "cast out sevens")  
 4 = denotes the modular value of the enclosed AB  
 with 4 the modulus. (cast out fours)  
 M = a month number from the table below

| JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | 4   | 4   | 0   | 2   | 5   | 0   | 3   | 6   | 1   | 4   | 6   |

The algorithm above applies only to the Gregorian calendar which began on Friday, October 15, 1582. The ten days immediately previous were omitted from the calendar, the day just before being Thursday, October 4, 1582 in the Julian calendar.

Do not confuse the Julian calendar with Julian Day numbers which are used in H-P's CALENDAR FUNCTIONS program (SD-04A). There is little or no relation between the two, in spite of the similarity of the names. The Julian calendar was established in the Roman empire by Julius Caesar with the advice of the astronomer Sosigenes to correct the confusion that had arisen between the year and the seasons. The year 46 B.C. was increased by intercalations to 445 days and his calendar was begun on 1-1-45 B.C. Due to the confusion resulting from it's adoption the intercalary days were incorrectly added until the error was corrected by Augustus Caesar in 8 B.C. who omitted further intercalations until A.D. 8. After 1-1-8 the calendar remained in this form until the Gregorian reform in 1582.

The Julian calendar assumed the year to be 365.250 days and corrected the discrepancy by adding an extra day every fourth year. Since the exact value of the fractional part is .24219878 an error slowly accumulated until the reform in 1582. That last reform consisted of:

1. Dropping 10 days from the calendar  
 (correcting the accumulated error)
2. Omitting the intercalary day in those century years not evenly divisible by 400.  
 Thus 1700, 1800, 1900, 2100 etc. are not leap years but 1600, 2000 are.

In the sixteenth century Josephus Justus Scaliger in honour of his father Julian, introduced the continuous era known as the Julian period. It is a continuous succession of days--no years, no months. It began 1-1-4713 B.C. The Julian day begins at noon. Since all days are consecutively numbered, the obvious value to astronomers and others is to determine the elapsed days between two dates. Merely subtract the corresponding Julian day numbers. Tables and calculator programs are available to determine the Julian day number for any date in history or the future.

The program entitled Julian calendar computes the day of the week for any date in the period 1-1-8 to and including 10-4-1582. For reasons stated above it may be erroneous back to 1-1-1. Be sure to enter a date such as 1-1-8 in this manner: 1.010008

**FRIDAY 13th** Rearranges the above algorithm to search the calendar for consecutive occurrences of a given week day on a given day of the month such as Fri 13th, Mon.1st etc.

**CALENDAR SEARCH** examines consecutive years for the occurrence of a given date on a given week day, such as Christmas on Sunday or July 4th on a Saturday. Expect to be surprised with Feb.29th on Sunday.

**MOON PHASE--** For those not familiar with the jargon the little sketch below should serve to explain the "age" or phase of the moon:

## FURTHER READING

Sky and Sextant. Practical Celestial Navigation, by John P. Budlong, is a 1975 copyrighted book with a special chapter on the use of hand-held calculators. The SR-50, HP-35, HP-45. Van Nostrand Reinhold Co., 5-3/4 X 8-1/2", hard-bound, 151 pages.

STEP KEY ENTRY 1 KEY CODE

|     |        |  |
|-----|--------|--|
| 1   | LBL A  |  |
|     | CLRG   |  |
|     | DISP 6 |  |
|     | STO 1  |  |
| 5   | DSPO   |  |
|     | INT    |  |
|     | STO 0  |  |
|     | RCL 1  |  |
|     | FRC    |  |
| 10  | EEX    |  |
|     | 2      |  |
|     | X      |  |
|     | STO 3  |  |
|     | INT    |  |
| 15  | STO 9  |  |
|     | RCL 3  |  |
|     | FRC    |  |
|     | EEX    |  |
|     | 4      |  |
| 20  | X      |  |
|     | STO 4  |  |
|     | 4      |  |
|     | +      |  |
|     | FRC    |  |
| 25  | X=0?   |  |
|     | GTO 3  |  |
|     | LBL 4  |  |
|     | RCL 4  |  |
|     | EEX    |  |
| 30  | 2      |  |
|     | +      |  |
|     | FRC    |  |
|     | EEX    |  |
| 35  | 2      |  |
|     | X      |  |
|     | 1      |  |
|     | +      |  |
|     | STO 5  |  |
| 40  | INT    |  |
|     | STO+9  |  |
|     | RCL 5  |  |
|     | FRC    |  |
|     | 1      |  |
| 45  | 2      |  |
|     | X      |  |
|     | STO+9  |  |
|     | 4      |  |
| 49  | +      |  |
| 50  | STO 6  |  |
|     | CLX    |  |
|     | SCI    |  |
|     | 4      |  |
|     | EEX    |  |
| 55  | 3      |  |
|     | CHS    |  |
|     | FIX    |  |
|     | RCL 6  |  |
|     | +      |  |
| 60  | INT    |  |
|     | STO+9  |  |
|     | RCL 4  |  |
|     | EEX    |  |
|     | 2      |  |
| 65  | +      |  |
|     | INT    |  |
|     | 4      |  |
|     | +      |  |
|     | FRC    |  |
| 70  | 3      |  |
|     | X      |  |
|     | CHS    |  |
|     | 6      |  |
|     | +      |  |
| 75  | STO+9  |  |
|     | RCL 0  |  |
|     | 1      |  |
|     | X=0?   |  |
|     | GTO 8  |  |
| 80  | RCL 0  |  |
|     | 2      |  |
|     | X=0?   |  |
|     | GTO C  |  |
|     | RCL 0  |  |
| 85  | 3      |  |
|     | X=0?   |  |
|     | GTO C  |  |
|     | RCL 0  |  |
|     | 4      |  |
| 90  | X=0?   |  |
|     | GTO D  |  |
|     | RCL 0  |  |
|     | 5      |  |
|     | X=0?   |  |
| 95  | GTO E  |  |
|     | RCL 0  |  |
|     | 6      |  |
|     | X=0?   |  |
|     | GTO 4  |  |
| 100 | RCL 0  |  |

STEP KEY ENTRY 2 KEY CODE

|     |       |  |
|-----|-------|--|
| 101 | 1     |  |
|     | X=0?  |  |
|     | GTO D |  |
|     | RCL 0 |  |
| 105 | 3     |  |
|     | X=0?  |  |
|     | GTO 6 |  |
|     | RCL 0 |  |
|     | 1     |  |
| 110 | X=0?  |  |
|     | GTO C |  |
|     | RCL 0 |  |
|     | 0     |  |
| 115 | X=0?  |  |
|     | GTO 8 |  |
|     | RCL 0 |  |
|     | 1     |  |
| 120 | X=0?  |  |
|     | GTO C |  |
|     | RCL 0 |  |
|     | 1     |  |
| 125 | X=0?  |  |
|     | GTO C |  |
|     | LBL 8 |  |
|     | 1     |  |
|     | STO+9 |  |
| 130 | GTO 2 |  |
|     | LBL C |  |
|     | 4     |  |
|     | STO+9 |  |
|     | GTO 2 |  |
| 135 | LBL D |  |
|     | 0     |  |
|     | STO+9 |  |
|     | GTO 2 |  |
| 140 | LBL E |  |
|     | 2     |  |
|     | STO+9 |  |
|     | GTO 2 |  |
|     | LBL 4 |  |
| 145 | STO+9 |  |
|     | GTO 2 |  |
|     | LBL 6 |  |
|     | 3     |  |
| 149 | STO+9 |  |
| 150 | GTO 2 |  |
|     | LBL 6 |  |
|     | 6     |  |
|     | STO+9 |  |
|     | GTO 2 |  |
| 155 | LBL 2 |  |
|     | RCL 9 |  |
|     | 7     |  |
|     | +     |  |
|     | FRC   |  |
| 160 | 7     |  |
|     | X     |  |
|     | SPC   |  |
|     | PRT X |  |
|     | R/S   |  |
| 165 | LBL 3 |  |
|     | RCL 4 |  |
|     | 4     |  |
|     | 0     |  |
| 170 | +     |  |
|     | FRC   |  |
|     | X=0?  |  |
|     | GTO 5 |  |
|     | RCL 4 |  |
| 175 | EEX   |  |
|     | 2     |  |
|     | +     |  |
|     | FRC   |  |
|     | X=0?  |  |
| 180 | GTO 4 |  |
|     | GTO 5 |  |
|     | LBL 5 |  |
|     | RCL 0 |  |
|     | 2     |  |
| 185 | X=0?  |  |
|     | X>0?  |  |
|     | GTO 4 |  |
|     | 1     |  |
|     | STO-9 |  |
| 190 | GTO 4 |  |
|     | R/S   |  |
| 195 |       |  |
| 200 |       |  |

1. GREGORIAN CALENDAR BY: DAN.M.FENSTERMACHER- 1437

2. BY:

1 GREGORIAN CALENDAR  
OCT. 15, 1582 TO DEC. 31, 9999 SUNDAY=1  
KEY IN DATE IN MM.DDYYYY FORMAT  
PRESS A

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| STEP  | INSTRUCTIONS   | INPUT DATA/UNITS | KEYS | OUTPUT DATA/UNITS |
|---|--|------------------|------|-------------------|
| 1   | LOAD PROGRAM CARD,<br>SIDES 1 & 2  |                  |      |                   |
| 2   | KEY IN VALID DATE IN<br>SAME FORMAT AS H-P USES<br>IN STANDARD PAC, I.E. -<br>MM.DDYYYY<br>(FIRST 'D' MUST BE 0 FOR<br>DAYS OF MONTH LESS THAN 10) |                  |      |                   |
| 3   | PRESS A<br>OUTPUT IS A SINGLE DIGIT<br>FOR DAY OF WEEK.<br>SUNDAY=1, MON.=2 ETC.<br>SAT.=0 or 7  |                  |      | D.O.W.            |
| THIS PROGRAM, LIKE H-P's, CAN NOT REJECT SPURIOUS<br>DATES. THE GREGORIAN CALENDAR BEGAN BY PAPAL<br>EDICT ON OCT. 15, 1582 - DATES PREVIOUS WERE IN THE<br>JULIAN CALENDAR. OCT. 5 thru OCT. 14, 1582 DO NOT<br>EXIST - THEY WERE STRICKEN FROM THE CALENDAR.<br>ONLY THOSE CENTURY YEARS DIVISIBLE BY 400 ARE<br>LEAP YEARS, THUS, 1600 & 2000 ARE LEAP YEARS BUT<br>1900, 1700, 2100 etc. ARE NOT. HENCE 2-29-1900 IS A<br>SPURIOUS DATE. DATES SUCH AS 14-37-1911 THOUGH<br>OBVIOUSLY SPURIOUS WILL BE COMPUTED BY THIS<br>PROGRAM. |  |                  |      |                   |

1. JULIAN CALENDAR BY: DAN M.FENSTERMACHER- 1438

2. BY:

1 JULIAN CALENDAR  
1-1-0 thru 10-4-1582 SUNDAY=1  
KEY IN DATE IN MM.DDYYYY FORMAT  
PRESS A

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2 SEE PROGRAM LISTING ON PAGE 20 (LEFT SIDE)

| STEP | INSTRUCTIONS   | INPUT DATA/UNITS | KEYS | OUTPUT DATA/UNITS |
|------|--|------------------|------|-------------------|
| 1    | LOAD PROGRAM CARD,<br>SIDES 1 & 2  |                  |      |                   |
| 2    | KEY IN VALID DATE IN<br>SAME FORMAT AS H-P USES<br>IN STANDARD PAC, I.E.<br>MM.DDYYYY<br>SIGNIFICANT ZEROS MUST<br>BE INCLUDED - EXAMPLE -<br>1-1-1 IS KEYED THUSLY:<br>1.010001 |                  |      |                   |
| 3    | PRESS A - PRINT OUT IS<br>DATE FOLLOWED BY A<br>SINGLE DIGIT FOR D.O.W.<br>SUNDAY = 1  |                  |      | DATE<br>D.O.W.    |

STEP KEY ENTRY 1 KEY CODE

|     |        |  |
|-----|--------|--|
| 1   | LBL A  |  |
|     | CLRG   |  |
|     | CFO    |  |
|     | STO 0  |  |
| 5   | DISP 6 |  |
|     | PRT X  |  |
|     | RCL 0  |  |
|     | FRC    |  |
|     | RFX    |  |
| 10  | 2      |  |
|     | X      |  |
|     | STO 1  |  |
|     | FRC    |  |
|     | RFX    |  |
| 15  | 4      |  |
|     | X      |  |
|     | RND    |  |
|     | STO 2  |  |
|     | 4      |  |
| 20  | RND    |  |
|     | FRC    |  |
|     | X=0?   |  |
|     | SFO    |  |
| 25  | RCL 2  |  |
|     | 2      |  |
|     | X>Y?   |  |
|     | CFO    |  |
|     | RCL 2  |  |
| 30  | 1      |  |
|     | 2      |  |
|     | 1      |  |
|     | STO 3  |  |
|     | INT    |  |
| 35  | E+     |  |
|     | RCL 3  |  |
|     | FRC    |  |
|     | 1      |  |
|     | 2      |  |
| 40  | X      |  |
|     | RND    |  |
|     | STO 4  |  |
|     | E+     |  |
|     | RCL 4  |  |
| 45  | 4      |  |
|     | 1      |  |
|     | DSP 2  |  |
|     | RND    |  |
| 49  | INT    |  |
| 50  | E+     |  |
|     | 4      |  |
|     | E+     |  |
|     | RCL 1  |  |
|     | INT    |  |
| 55  | E+     |  |
|     | RCL 0  |  |
|     | INT    |  |
|     | STO 5  |  |
|     | FO?    |  |
| 60  | GTO 5  |  |
|     | GTO 5  |  |
|     | LBL 5  |  |
|     | 2      |  |
|     | RCL 5  |  |
| 65  | X>Y?   |  |
|     | GTO 5  |  |
|     | 1      |  |
|     | CHS    |  |
|     | E+     |  |
| 70  | GTO 5  |  |
|     | LBL 5  |  |
|     | RCL 5  |  |
|     | 1      |  |
|     | X=Y?   |  |
| 75  | GTO 5  |  |
|     | RCL 5  |  |
|     | 2      |  |
|     | X=Y?   |  |
|     | GTO 5  |  |
| 80  | RCL 5  |  |
|     | 3      |  |
|     | X=Y?   |  |
|     | GTO 5  |  |
|     | RCL 5  |  |
| 85  | 4      |  |
|     | X=Y?   |  |
|     | GTO 5  |  |
|     | RCL 5  |  |
|     | 5      |  |
| 90  | X=Y?   |  |
|     | GTO 0  |  |
|     | RCL 5  |  |
|     | 4      |  |
|     | X=Y?   |  |
| 95  | GTO 1  |  |
|     | RCL 5  |  |
|     | 7      |  |
|     | X=Y?   |  |
|     | GTO 5  |  |
| 100 | RCL 5  |  |

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STEP KEY ENTRY 2 KEY CODE

|     |                  |  |
|-----|------------------|--|
| 101 | 1                |  |
|     | X=Y?             |  |
|     | GTO 2            |  |
|     | RCL 5            |  |
| 105 | 1                |  |
|     | X=Y?             |  |
|     | GTO 3            |  |
|     | RCL 5            |  |
|     | 1                |  |
| 110 | 0                |  |
|     | X=Y?             |  |
|     | GTO 4            |  |
|     | RCL 5            |  |
|     | 1                |  |
| 115 | 1                |  |
|     | X=Y?             |  |
|     | GTO 5            |  |
|     | RCL 5            |  |
|     | 1                |  |
| 120 | 2                |  |
|     | X=Y?             |  |
|     | GTO 5            |  |
|     | LBL 0            |  |
|     | 1                |  |
| 125 | E+               |  |
|     | GTO 5            |  |
|     | LBL 5            |  |
|     | 4                |  |
|     | E+               |  |
| 130 | GTO 5            |  |
|     | LBL 0            |  |
|     | E+               |  |
|     | GTO 5            |  |
|     | LBL 1            |  |
| 135 | 5                |  |
|     | E+               |  |
|     | GTO 5            |  |
|     | LBL 2            |  |
| 140 | 3                |  |
|     | E+               |  |
|     | GTO 5            |  |
|     | LBL 3            |  |
| 145 | 6                |  |
|     | E+               |  |
|     | GTO 5            |  |
|     | LBL 3            |  |
| 149 | RCL 5            |  |
| 150 | 7                |  |
|     | FRC              |  |
|     | 7                |  |
|     | X                |  |
|     | DISP 0           |  |
| 155 | PRT X            |  |
|     | STO 6            |  |
|     | RCL 5            |  |
|     | CHS              |  |
|     | E+               |  |
| 160 | RCL 6            |  |
|     | R/S              |  |
| 165 |                  |  |
| 170 | JULIAN           |  |
|     | CALENDAR         |  |
| 175 | SEE PAGE 18      |  |
|     | FOR INSTRUCTIONS |  |
| 180 |                  |  |
| 185 |                  |  |
| 190 |                  |  |
| 195 |                  |  |
| 200 |                  |  |

STEP KEY ENTRY 1 KEY CODE

|     |       |  |
|-----|-------|--|
| 1   | LBL A |  |
|     | STO 1 |  |
|     | INT   |  |
|     | STO 1 |  |
| 5   | RCL 1 |  |
|     | FRC   |  |
|     | RFX   |  |
|     | 2     |  |
|     | X     |  |
| 10  | STO A |  |
|     | INT   |  |
|     | STO 5 |  |
|     | RCL A |  |
|     | FRC   |  |
| 15  | RFX   |  |
|     | X     |  |
|     | STO B |  |
|     | 7     |  |
| 20  | RCL 1 |  |
|     | X>Y?  |  |
|     | GTO 6 |  |
|     | GTO 7 |  |
|     | LBL 6 |  |
| 25  | RCL 1 |  |
|     | 2     |  |
|     | STO+5 |  |
|     | GTO 4 |  |
| 30  | LBL 7 |  |
|     | 5     |  |
|     | RCL 1 |  |
|     | X>Y?  |  |
|     | GTO 8 |  |
| 35  | GTO 9 |  |
|     | LBL 8 |  |
|     | 4     |  |
|     | STO+5 |  |
|     | GTO 4 |  |
| 40  | LBL 9 |  |
|     | 1     |  |
|     | RCL 1 |  |
|     | X>Y?  |  |
| 45  | GTO 4 |  |
|     | GTO 4 |  |
|     | LBL 9 |  |
|     | 2     |  |
|     | O     |  |
| 49  | RCL 1 |  |
| 50  | 4     |  |
|     | FRC   |  |
|     | X=0?  |  |
|     | GTO 0 |  |
|     | GTO 4 |  |
| 55  | LBL 0 |  |
|     | 2     |  |
|     | STO+5 |  |
|     | GTO 4 |  |
| 60  | GTO 5 |  |
|     | LBL 5 |  |
|     | 1     |  |
|     | 2     |  |
|     | 3     |  |
| 65  | STO 9 |  |
|     | 2     |  |
|     | 2     |  |
|     | 2     |  |
|     | 3     |  |
| 70  | STO 8 |  |
|     | 3     |  |
|     | 2     |  |
|     | 3     |  |
|     | STO 7 |  |
|     | 4     |  |
| 75  | 2     |  |
|     | 3     |  |
|     | STO 6 |  |
|     | 1     |  |
|     | 5     |  |
| 80  | 7     |  |
|     | STO 2 |  |
|     | RCL 5 |  |
|     | RCL 2 |  |
| 85  | STO 5 |  |
|     | 1     |  |
|     | 1     |  |
| 90  | X     |  |
|     | 0     |  |
|     | 1     |  |
|     | FRC   |  |
| 95  | 0     |  |
|     | X     |  |
|     | STO 4 |  |
|     | 1     |  |
|     | STO+4 |  |
| 100 | GTO 5 |  |

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STEP KEY ENTRY 2 KEY CODE

|     |                  |  |
|-----|------------------|--|
| 101 | LBL B            |  |
|     | RCL 2            |  |
|     | 1                |  |
| 105 | 1                |  |
|     | INT              |  |
|     | STO+4            |  |
|     | GTO 6            |  |
| 110 | LBL 6            |  |
|     | RCL 4            |  |
|     | RCL 5            |  |
|     | 1                |  |
|     | 2                |  |
| 115 | 0                |  |
|     | 1                |  |
|     | FRC              |  |
|     | 3                |  |
|     | 0                |  |
|     | X                |  |
| 120 | DSP 0            |  |
|     | RND              |  |
|     | PRT X            |  |
|     | R/S              |  |
|     | LBL 5            |  |
| 125 | RCL 3            |  |
|     | RCL 4            |  |
|     | RCL 5            |  |
|     | X>Y?             |  |
|     | GTO 6            |  |
|     | GTO 6            |  |
| 130 | LBL 6            |  |
|     | RCL 3            |  |
|     | RCL 5            |  |
|     | RCL 6            |  |
|     | X>Y?             |  |
|     | GTO 1            |  |
| 135 | GTO 1            |  |
|     | LBL 3            |  |
|     | RCL 3            |  |
|     | RCL 7            |  |
|     | X>Y?             |  |
| 140 | GTO 1            |  |
|     | GTO 2            |  |
|     | LBL 2            |  |
|     | RCL 3            |  |
| 145 | RCL 6            |  |
|     | X>Y?             |  |
|     | GTO 0            |  |
|     | GTO 3            |  |
|     | LBL 3            |  |
| 149 | 0                |  |
| 150 | ENT 4            |  |
|     | 1                |  |
|     | R/S              |  |
|     | LBL 1            |  |
|     | 1                |  |
| 155 | STO-4            |  |
|     | GTO 6            |  |
|     | LBL 0            |  |
|     | 2                |  |
|     | STO-4            |  |
| 160 | GTO 6            |  |
|     | R/S              |  |
| 165 |                  |  |
| 170 | MOON             |  |
|     | PHASE            |  |
| 175 | SEE PAGE 19      |  |
|     | FOR INSTRUCTIONS |  |
| 180 |                  |  |
| 185 |                  |  |
| 190 |                  |  |
| 195 |                  |  |
| 200 |                  |  |