# CALCULATING THE UPOSATHA MOONDAYS

v0.1 · 6th October 2014 · link

**TL,DR**

Too Long, Didn't Read

- The aim here is to describe the practical steps to calculate the *uposatha* Full- and New Moon days, and indicate the astronomical cycles that underlie the method.
- Alternate 30 and 29 day lunar months, 12 months make one year. Add an extra month 7 times in every 19 years, add an extra day 11 times in every 57 years.
- Conventions on how to practise this can differ by countries and groups, resulting in consistent but different calendars.
- Unforseen adjustments to the predicted uposatha days in the published Royal Calendar can be expected.

**Unresolved Questions:**

- When is the adhikavara inserted?
- Only Mahanikaya adds adhikavara?

This document is still work-in-progress and represents only what I've been able to find description of. See the links in the Bibliography or download a zip of this document and sources.

Comments, corrections or further information would be greatly appreciated. `{{{email}}}`

## 1 THAILAND, MAHĀNIKĀYA METHOD

### 1.1 ALTERNATE 30 AND 29 DAY MONTHS

Counting from the last Full Moon of the previous lunar year (which may be in January), the first month is 30 days, the second is 29 days:

| | | |
|---|---|---|
| 15 days | ● New Moon | First uposatha of the Cold Season |
| 15 days | ○ Full Moon | End of first month, 30 days |
| 15 days | ● New Moon | |
| 14 days | ○ Full Moon | End of second month, 29 days |

The ◐ Waxing- and ◑ Waning Moons are on the 8th day.

| | Su | | | | | | Su | | | | | | | Su | | | | | | | Su | | | | | | | Su |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 Jan | 1 | ◑ | 3 | 4 | 5 | 6 | 7 | ● | 9 | 10 | 11 | 12 | 13 | 14 | 15 | ◐ | 17 | 18 | 19 | 20 | 21 | 22 | ○ | 24 | 25 | 26 | 27 | 28 | 29 | 30 | ◑ |
| 2016 Feb | 1 | 2 | 3 | 4 | 5 | 6 | ● | 8 | 9 | 10 | 11 | 12 | 13 | 14 | ◐ | 16 | 17 | 18 | 19 | 20 | 21 | ○ | 23 | 24 | 25 | 26 | 27 | 28 | 29 | | |

Keep alternating 30 and 29 day months. One season is four months, one year is three seasons: Cold-, Hot- and Rainy Season. In a year with nothing special, the calendar is finished. See Table ?? for the Pali names of months and seasons.

In some years an extra month (adhikamāsa) or an extra day (adhikavāra) has to be added.

## 1.2 Adding the extra month

In Thai practice, the extra month (adhikamāsa) is a 30 day month inserted after the 8th month (*Āsāḷha*), at the end of the Hot Season. The convention is to call this the 'second 8th' or 'second *Āsāḷha*', marked as 8/8.

Vassa starts after the 2nd Āsāḷha, on the day after the Full Moon uposatha of 8/8.

| order | name | days |
|---|---|---|
| … | | |
| 8 | Āsāḷha | 29 |
| 8/8 | 2nd Āsāḷha | 30 |
| 9 | Savaṇa | 30 |

The extra month is added 7 times in every 19 year, in a repeating pattern of 3-3-2 - 3-3-3-2 years. See Table 1.1.

Table 1.1: 19-year cycles of the adhikamāsa[?]

| | | | |
|---|---|---|---|
| | 1 | 1997 | 2016 |
| | 2 | | |
| 3 | 3 | 1999 | 2018 |
| | 4 | | |
| | 5 | | |
| 3 | 6 | 2002 | 2021 |
| | 7 | | |
| 2 | 8 | 2004 | 2023 |
| | 9 | | |
| | 10 | | |
| 3 | 11 | 2007 | 2026 |
| | 12 | | |
| | 13 | | |
| 3 | 14 | 2010 | 2029 |
| | 15 | | |
| | 16 | | |
| 3 | 17 | 2013 | 2032 |
| | 18 | | |
| 2 | 19 | 2015 | 2034 |

## 1.3 Adding the extra day

The extra day (adhikavāra) is added 11 times in every 57 year.

> It appears to be added every few years in the 3rd uposatha of the Hot Season – making it a fifteen-day uposatha instead of the expected fourteen-day. King Mongkut apparently devised a method to abandon this practice, but the issue remains a mistery…[?]

### 1.4 Major Moondays

Buddhist communities observe key annual events on the Full Moon days of four lunar months, see Table 1.2.

Table 1.2: Major Moondays

| | Lunar Month | |
|---|---|---|
| Māgha Pūjā | 3rd | |
| Visākha Pūjā | 6th | |
| Āsāḷha Pūjā | 8th | Entering Vassa on the next day |
| Assayuja Pūjā | 11th | Pavāraṇā Day, the end of Vassa |

The Full Moon day is on the last day of a given month. The next month starts on the following day (first day of the waning phase), thus the first uposatha will be on a New Moon.

## 2 Adding the extra month, Pali method

*The following is adapted from Ajahn Khemanando for recent years.*[?]

Table 2.1 shows the 19-year cycle between 1997-2034.

Table 2.1: Adhikamāsa accoding to the Pali method

| | | | | Month | Season | New | Full |
|---|---|---|---|---|---|---|---|
| | 1 | 1997 | 2016 | | | | |
| | 2 | | | | | | |
| 3 | 3 | 1999 | 2018 | 5 | Hot | 4 | 8/8 |
| | 4 | | | | | | |
| | 5 | | | 2 | Cold | 12 | 5 |
| 3 | 6 | 2002 | 2021 | | Cold | 12 | 5 |
| | 7 | | | | | | |
| 2 | 8 | 2004 | 2023 | 10 | Rainy | 8 | 12 |
| | 9 | | | | | | |
| | 10 | | | | | | |
| 3 | 11 | 2007 | 2026 | 7 | Hot | 4 | 8/8 |
| | 12 | | | | | | |
| | 13 | | | 3 | Cold | 12 | 5 |
| 3 | 14 | 2010 | 2029 | | Cold | 12 | 5 |
| | 15 | | | | | | |
| | 16 | | | 12 | Cold | 12 | 5 |
| 3 | 17 | 2013 | 2032 | | Cold | 12 | 5 |
| | 18 | | | | | | |
| 2 | 19 | 2015 | 2034 | 8 | Rainy | 8 | 12 |

**Month:** the Thai lunar month into which the adhikamāsa is inserted

**Season:** the season in which the adhikamāsa fall in that particular year

**New and Full:** the first and last uposatha of the 5-month season in which the adhikamāsa falls, numbered in Thai lunar months

If the adhikamāsa falls on the 2nd, 3rd, or 12th Thai lunar month, there will be *two* 8th months (8 and 8/8) the following year.

E.g. In 2001, the adhikamāsa comes as the 2nd lunar month in the Cold Season, so the following year, 2002, has two 8th months (8 and 8/8). There will thus be *ten* uposathas in the Cold Season, the first being the New Moon of the 12th Thai lunar month (2001) and the last being the Full Moon of the 5th Thai lunar month, 2002.

## 3 NAMES OF THE MONTHS

Note on zodiacs, full moon at midnight, etc.

Table 3.1: Lunar and Solar Months and Zodiacs[?]

* marks 29 day months having a 14 day New Moon (*amāvasī cātuddasī*).

| Season | Lunar Month | Solar Month | Solar Zodiac (Western / Sanskrit) |
|---|---|---|---|
| Hemanta-utu | Magasira-māsa | December | Sagittarius / Dhanus |
| Cold Season | Phussa-māsa* | January | Capricorn / Makara |
| | Māgha-māsa | February | Aquarius / Kumbha |
| | Phagguṇa-māsa* | March | Pisces / Mīna |
| Gimha-utu | Citta-māsa | April | Aries / Meṣa |
| Hot Season | Visākha-māsa* | May | Taurus / Vṛṣabha |
| | Jeṭṭha-māsa | June | Gemini / Mithuna |
| | Āsāḷha-māsa* | July | Cancer / Karkaṭa |
| Vassāna-utu | Savaṇa-māsa | August | Leo / Siṃha |
| Rainy Season | Bhaddapāda-māsa* | September | Virgo / Kanyā |
| | Assayuja-māsa | October | Libra / Tulā |
| | Kattika-māsa* | November | Scorpio / Vṛścika |

## 4 THE THAI LUNI-SOLAR CALENDAR

Luni-solar calendars are constructed so to count years according to the *solar* cycle, but to count months according to the *lunar* cycle.

| | |
|---|---|
| tropical year[1] of the Earth | 365.24219 days |
| synodic month[2] of the Moon | ~29.53 days, can vary up to 7 hours |

[1] tropical year: the time it takes the Earth to complete an orbit around the Sun

[2] synodic month: the time it takes the Moon to reach the same visual phase

The epoch of the Thai calendar is 25 March 638 CE.

The Thai luni-solar calendar is *procedural*, it uses a couple of constant, key numbers derived from astronomical observations, and applies a series of mechanical calculations (i.e. the "rules") again and again to generate the dates of lunar phases and new years.

> This working is deliberately concise, since it thereby reflects how the calculation would have been made by a South East Asian calendrist. Each stage is subjected to an operation learnt by rote, and the underlying theory disappears from view. The rote operations, however, will provide a valid answer for any date in any year. It seemed greatly preferable to set out the procedure thus starkly, rather than to give a detailed exposition of what is involved.[?]

Southeast Asian astronomers refined a fraction to obtain the length of the year:

## 4.1 Year Types

We are concerned with three types of calendar years:

**Cal A** Normal with 354 days

**Cal B** Adhikavāra with 355 days

**Cal C** Adhikamāsa with 384 days

Comparing these to normal and solar leap years:

| | A | B | C |
|---|---|---|---|
| Lunar | 354 | 355 | 384 |
| Solar | 365 | 365 | 365 |
| difference | \+11 | \+10 | -19 |
| | A | B | C |
| Lunar | 354 | 355 | 384 |
| Solar Leap | 366 | 366 | 366 |
| difference | \+12 | \+11 | -18 |

## 4.2 Adhikamat years

The *suriyayatra* principle to determine adhikamat years is:

> "If the day of *thaloengsok* (astronomical New Year) lies either within 25 to 29 (in Citta-māsa) or 1 to 5 (in Visākha-māsa), then the year is adhikamat."[?]

The *thaloengsok* is the value of T in Figure ??.

## 4.3 Adhikawan years

> Two components of the *suriyayatra* are known as the *kammacubala* and the *avoman*, and it is the values of these two elemets at the start of the year that determine the matter:
>
> - if the kammacubala value is 207 or less, then the year is leap year

$$\frac{292207}{800} = 365.25875\text{days} \tag{4.1}$$

[?]

This is 0.01656 days longer than the modern measurement (1 day in ~60 years). Remarkably, the *suriyayatra* accounts for this and generates accurate results:

> For instance, a Pagan inscription of 14 April 1288 AD maintains that at midnight the sun's position was 0 signs, 19 degrees and 59 minutes: the computer program returns 0 19 59.[?]

Nonetheless, the calendar dates published in Thailand in a given year reflect not only these principles, but also additional adjustments which cannot be forseen or retraced.

> The historical record however, frequently defies prediction, forcing the conclusion that the pressure upon the *horas* (astronomers / astrologers) was not to follow the "rules" but merely, within some more leisurely constraints, to ensure that the calendar did not get out of control.[?]

- in a leap year, if the avoman is 126 or less, the year will have an extra day
- in a normal year, if the avoman is 137 or less, the year will have and extra day[?]

The *kammacubala* and *avoman* are the value of K and A in Figure ??.

In Thailand, years with an extra month are not allowed to also have an extra day, and the adhikawan will be assigned to the next year.

## 4.4 Suriyayatra formulas

Figure 4.1: Finding astronomical values with the /suriyayatra/ calculation[?]

Start with Y, the given Common Era year. Significant values are assigned names. K for *kammacubala*, A for *avoman*, N for *thaloengsok* (the New Year).

$$
\begin{aligned}
a &= ((Y - 638) * 292207) + 373 \\
h &= \lfloor a/800 + 1 \rfloor \\
K &= 800 - a \bmod 800 \\
A &= ((h * 11) + 650) \bmod 692 \\
b &= \lfloor ((h * 11) + 650)/692 \rfloor \\
T &= (b + h) \bmod 30
\end{aligned}
$$

| | | | | year | type | Asalha | 2nd Asalha |
|---|---|---|---|---|---|---|---|
| | | 0 | | 1320 | m | 19:42 | 22:24 |
| 0 | | 1 | | 1321 | d | 21:05 | |
| 1 | | 2 | | 1322 | | 20:40 | |
| 2 | | 3 | 3 | 1323 | m | 19:12 | 22:00 |
| 3 | | 4 | | 1324 | | 20:38 | |
| 4 | 4 | 5 | | 1325 | d | 19:34 | |
| 5 | | 6 | 3 | 1326 | m | 19:38 | 22:05 |
| 6 | | 7 | | 1327 | | 21:15 | |
| 7 | | 8 | 2 | 1328 | m | 19:20 | 22:55 |
| 8 | | 9 | | 1329 | | 21:48 | |
| 9 | 5 | 10 | | 1330 | d | 20:26 | |
| 10 | | 11 | 3 | 1331 | m | 19:59 | 22:50 |
| 11 | | 12 | | 1332 | | 21:20 | |
| 12 | | 13 | | 1333 | | 20:02 | |
| 13 | | 14 | 3 | 1334 | m | 19:03 | 21:33 |
| 14 | 5 | 15 | | 1335 | d | 20:40 | |
| 15 | | 16 | | 1336 | | 20:44 | |
| 16 | | 17 | 3 | 1337 | m | 19:44 | 22:19 |
| 17 | | 18 | | 1338 | | 21:11 | |
| 18 | | 19 | 2 | 1339 | m | 19:45 | 22:35 |
| 19 | 5 | | | 1340 | d | 21:05 | |

## 5 BIBLIOGRAPHY


[1] Hāsapañño Bhikkhu. The lunar and solar zodiac, 2011.

[2] Khemanando Bhikkhu. The cycle of the adhikamāsa.

[3] J.C. Eade. Rules for interpolation in the thai calendar: Suriyayatra versus the sasana. *Journal of the Siam Society*, 88(1 and 2), 2000. Accessed 2014-10-02.


## 6 COLOPHON

Written in Org-mode. Sources are at `Github`.

Comments, corrections or further information would be greatly appreciated.


`Gambhiro Bhikkhu <gambhiro.bhikkhu.85@gmail.com>`


Last updated: