7

The Islamic Calendar

The number of months with God is twelve in accordance with God's law since the day he created the heavens and the Earth . . . Intercalating a month is adding to unbelief.

Koran (IX, 36–37)

7.1 Structure and Implementation

The Islamic calendar is a straightforward, strictly lunar calendar, with no intercalation of months (unlike lunisolar calendars). The average lunar year is about $354\frac{11}{30}$ days, so the Islamic calendar's independence of the solar cycle means that its months do not occur in fixed seasons but migrate through the solar year over a period of about 32 solar years.[1] Days begin at sunset. In this chapter, we describe the arithmetic Islamic calendar in which months follow a set pattern; for religious purposes, virtually all Muslims (except the Ismāʿīlīs and a few other sects) follow an observation-based calendar (described in Section 14.9) and use the arithmetic calendar only for estimation.

The week begins on Sunday; the days Sunday–Thursday are numbered, not named:

Sunday	yaum al-aḥad (the first day)	يَوْم الأَحد
Monday	yaum al-ithnayna (the second day)	يَوْم الاثنين
Tuesday	yaum ath-thalāthā' (the third day)	يَوْم الثلاَثاء
Wednesday	yaum al-arbaʿā' (the fourth day)	يَوْم الأَربعَاء

[1] There was an interesting consequence to the strict lunar nature of the calendar in the Ottoman Empire. The Islamic calendar, as the official calendar, was used for expenditures, but revenue collecting generally followed the solar year because seasons affected income-producing activities such as agriculture, shipping, and mining. For every 32 solar years there are 33 Islamic years; thus every 33 Islamic years had one "skip" year, called a *sıvış* year in Turkish, for which there was no income. Such years precipitated crises, such as in 852 A.H. (1448 C.E.) in which the troops' pay was six months in arrears, resulting in a lack of resistance on their part when Hungarian and Serbian forces entered the Ottoman Empire. A detailed analyis of the phenomenon is given in H. Sahillioğlu's article, "*Sıvış* Year Crises in the Ottoman Empire," *Studies in the Economic History of the Middle East*, M. A. Cook, ed., Oxford University Press, London, pp. 230–252, 1970.

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Thursday	yaum al-ẖamīs (the fifth day)	يَوْم الخَميس
Friday	yaum al-jum'a (the day of assembly)	يَوْم الجُمعة
Saturday	yaum as-sabt (the sabbath day)	يَوْم السَبْت

The calendar is computed, by the majority of the Muslim world, starting at sunset of Thursday, July 15, 622 C.E. (Julian), the year of Mohammed's migration to Medina from Mecca.[2] The introduction of the calendar is often attributed to the Caliph 'Umar in 639 C.E., but there is evidence that it was in use before his succession. In essence, Muslims count R.D. 227015 = Friday, July 16, 622 C.E. (Julian) as the beginning of the Islamic year 1, that is, as Muḥarram 1, A.H.[3] 1, and thus we define

$$\textbf{islamic-epoch} \stackrel{\text{def}}{=} \textbf{fixed-from-julian}\left(\begin{array}{|c|c|c|}\hline 622 \text{ C.E.} & \textbf{july} & 16 \\ \hline\end{array}\right) \tag{7.1}$$

There are 12 Islamic months, which contain, alternately, 29 or 30 days:

(1) Muḥarram	مُحَرَّم	30 days
(2) Ṣafar	صَفَر	29 days
(3) Rabī' I (Rabī' al-Awwal)	رَبيع الأَوَّل	30 days
(4) Rabī' II (Rabī' al-Āḥir)	رَبيع الآخِر	29 days
(5) Jumādā I (Jumādā al-Ūlā)	جُمَادَى الأُولَى	30 days
(6) Jumādā II (Jumādā al-Āḥira)	جُمَادَى الآخِرة	29 days
(7) Rajab	رَجَب	30 days
(8) Sha'bān	شَعبَان	29 days
(9) Ramaḍān	رَمَضَان	30 days
(10) Shawwāl	شَوَّال	29 days
(11) Dhu al-Qa'da	ذو القَعدة	30 days
(12) Dhu al-Ḥijja	ذو الحِجَّة	29 {30} days

The leap-year structure is given in curly brackets—the last month, Dhu al-Ḥijja, contains 30 days in years 2, 5, 7, 10, 13, 16, 18, 21, 24, 26, and 29 of a 30-year cycle. This gives an average month of $29.5305555\cdots$ days and an average year of $354.3666\cdots = 354\frac{11}{30}$ days. The cycle of common and leap years can be expressed concisely by observing that an Islamic year y is a leap year if and only if $(11y + 14) \bmod 30$ is less than 11; this is an instance of formula (1.83) with $c = 30$, $l = 11$, and $\Delta = 4$:

[2] The Arabic term *hijra*, used to denote the beginning of the Islamic epoch, signifies "emigration," "abandonment," or "flight."

[3] *Anno Hegiræ*; in the year of the Hegira (Mohammed's emigration to Medina)—see the previous footnote.

$$\textbf{islamic-leap-year?}\,(\textit{i-year}) \stackrel{\text{def}}{=} ((14 + 11 \times \textit{i-year}) \bmod 30) < 11 \tag{7.2}$$

We will never need this function, however.

Some Muslims take year 15 of the 30-year cycle as a leap year instead of year 16. This variant structure, which was used by Bar Hebræus (Gregory Abu'l-Faraj), John Greaves (1650; based on tables of Ulugh Beg), Birashk [1], and some Microsoft products,[4] corresponds to $L = 354$, $c = 30$, $l = 11$, and $\Delta = 15$ in the cycle formulas from Section 1.14; our functions thus require only minor modification for this variant leap-year rule.[5] The Bohras (an Ismailite Muslim sect of about 1 million in India) follow a book called *Sahifa*, giving leap years 2, 5, 8, 10, 13, 16, 19, 21, 24, 27, and 29; this corresponds to $\Delta = 1$. Their epoch is Thursday, July 15, 622 C.E. (Julian).

To convert an Islamic date to its R.D. equivalent, start at **islamic-epoch** − 1, the R.D. number of the last day before the epoch; to this add the number of days between that date and the last day of the year preceding the given year [using formula (1.86)], the number of days in prior months in the given year, and the number of days in the given month, up to and including the given day. The number of days in months prior to the given month is also computed by (1.86) because the pattern of Islamic month lengths in an ordinary year satisfies the cycle formulas of Section 1.14 with $c = 12$, $l = 6$, $\Delta = 1$ (to count months from 1 instead of 0), and $L = 29$; because the leap day is day 30 of month 12, this works for leap years also:

$$\textbf{fixed-from-islamic}\left(\boxed{\textit{year}\ \big|\ \textit{month}\ \big|\ \textit{day}}\right) \stackrel{\text{def}}{=} \tag{7.3}$$

$$\textbf{islamic-epoch} - 1 + (\textit{year} - 1) \times 354 + \left\lfloor \frac{1}{30} \times (3 + 11 \times \textit{year}) \right\rfloor + 29 \times (\textit{month} - 1) + \left\lfloor \frac{\textit{month}}{2} \right\rfloor + \textit{day}$$

Computing the Islamic date equivalent to a given R.D. date is slightly more complicated (though it is more straightforward than the computations for the Gregorian calendar or the Julian). We can calculate the exact value of the year using formula (1.90). We want to determine the month number in the same way; unfortunately, determining the month cannot be done directly from (1.90) using the values $c = 12$, $l = 6$, $\Delta = 1$, and $L = 29$, because these values describe the common-year month lengths, not those for the leap year. Indeed, no set of values with $c = 12$ can work properly in the cycle-length formulas for the leap year because there are three 30-day months in a row (months 11, 12, and 1). However, the values $c = 11$, $l = 6$, $\Delta = 10$, $L = 29$ actually do work—not completely, but over the range $0 \leqslant n \leqslant 354$ in (1.90), which is all we care about; thus (7.3) remains correct if $\lfloor \textit{month}/2 \rfloor$ is replaced with $\lfloor (6 \times \textit{month} - 1)/11 \rfloor$. Hence the month can be determined using (1.86), the day of the month is determined by subtraction, and we obtain:

[4] Microsoft inexplicably calls this version the "Kuwaiti algorithm."

[5] Specifically, the following three changes are needed: replacing 14 by 15 in **islamic-leap-year?**, replacing the numerator $3 + 11 \times \textit{year}$ by $4 + 11 \times \textit{year}$ in **fixed-from-islamic**, and replacing the 10646 by 10645 in the numerator of the value for *year* in **islamic-from-fixed**.

$$\textbf{islamic-from-fixed}\,(date) \stackrel{\text{def}}{=} \boxed{\ year\ \big|\ month\ \big|\ day\ } \tag{7.4}$$

where

$$\begin{aligned}
year &= \left\lfloor \frac{1}{10631} \times (30 \times (date - \textbf{islamic-epoch}) + 10646) \right\rfloor \\
prior\text{-}days &= date - \textbf{fixed-from-islamic}\left(\boxed{\ year\ \big|\ 1\ \big|\ 1\ } \right) \\
month &= \left\lfloor \frac{1}{325} \times (11 \times prior\text{-}days + 330) \right\rfloor \\
day &= date - \textbf{fixed-from-islamic}\left(\boxed{\ year\ \big|\ month\ \big|\ 1\ } \right) + 1
\end{aligned}$$

It is important to realize that, to a great extent, the foregoing calculations are merely hypothetical because there are many disparate forms of the Islamic calendar [6]. Furthermore, much of the Islamic world relies not on the calculations of this *arithmetical* calendar at all but on proclamation of the new moon, by religious authorities, based on the visibility of the lunar crescent. Consequently, the dates given by the functions here can be in error by a day or two from what will actually be observed in various parts of the Islamic world; this is unavoidable.

One could use astronomical functions (see Chapter 14) to determine the likely date of visibility of a new moon (see [5]). The calculation of such an astronomical Islamic calendar—sketched in Section 18.3—is quite intricate and not generally accepted.

7.2 Holidays

Only approximate positions have been used for predicting the commencement of a Hijri month, as accurate places cannot be computed without a great amount of labour ... Users of this Diglott Calendar must, therefore, at the commencement of each year correct the dates with those in the official Block Calendar issued by the Nizamiah Observatory.

Director of Nizamiah Observatory, quoted by Mazhar Husain:
Diglott Calendar, vol. II, p. iii (1961)

Determining the R.D. dates of holidays occurring in a given Gregorian year is complicated, because an Islamic year is always shorter than the Gregorian year, and thus each Gregorian year contains parts of at least 2 and sometimes 3 successive Islamic years. Hence, any given Islamic date occurs at least once and possibly twice in any given Gregorian year. For example, Islamic New Year (Muḥarram 1) occurred twice in 1943: on January 8 and again on December 28. Accordingly, we approach the problem of the Islamic holidays by writing a general function to return a list of the R.D. dates of a given Islamic date occurring in a given Gregorian year:

$$\textbf{islamic-in-gregorian}\,(i\text{-}month, i\text{-}day, g\text{-}year) \stackrel{\text{def}}{=} \tag{7.5}$$
$$\{date_0, date_1, date_2\} \cap \textbf{gregorian-year-range}\,(g\text{-}year)$$

where

$$jan_1 = \textbf{gregorian-new-year}\,(g\text{-}year)$$

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$$
\begin{aligned}
y &= (\textbf{islamic-from-fixed}\,(jan_1))_{\textbf{year}}\\
date_0 &= \textbf{fixed-from-islamic}\left(\boxed{\,y \mid i\text{-}month \mid i\text{-}day\,}\right)\\
date_1 &= \textbf{fixed-from-islamic}\left(\boxed{\,y+1 \mid i\text{-}month \mid i\text{-}day\,}\right)\\
date_2 &= \textbf{fixed-from-islamic}\left(\boxed{\,y+2 \mid i\text{-}month \mid i\text{-}day\,}\right)
\end{aligned}
$$

There is little uniformity among the Islamic sects and countries as to holidays. In general, the principal holidays of the Islamic year are Islamic New Year (Muḥarram 1), ‘Ashūrā’ (Muḥarram 10), Mawlid (Rabī‘ I 12), Lailat-al-Mi‘rāj (Rajab 27), Lailat-al-Barā’a (Sha‘bān 15), Ramadan (Ramaḍān 1), Lailat-al-Kadr (Ramaḍān 27), Eid ul-Fitr (Shawwāl 1), and Eid ul-Adha (Dhu al-Ḥijja 10). Other days, too, have religious significance—for example, the entire month of Ramaḍān. Like all Islamic days, an Islamic holiday begins at sunset the prior evening. We can determine a list of the corresponding R.D. dates of occurrence in a given Gregorian year by using **islamic-in-gregorian** above, as in

$$
\textbf{mawlid}\,(g\text{-}year) \stackrel{\text{def}}{=} \textbf{islamic-in-gregorian}\,(3, 12, g\text{-}year) \tag{7.6}
$$

It bears reiterating that the determination of the Islamic holidays cannot be fully accurate because the actual day of their occurrence depends on proclamation by religious authorities.

References

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[3] S. B. Burnaby, *Elements of the Jewish and Muhammadan Calendars, with Rules and Tables and Explanatory Notes on the Julian and Gregorian Calendars*, George Bell and Sons, London, 1901.

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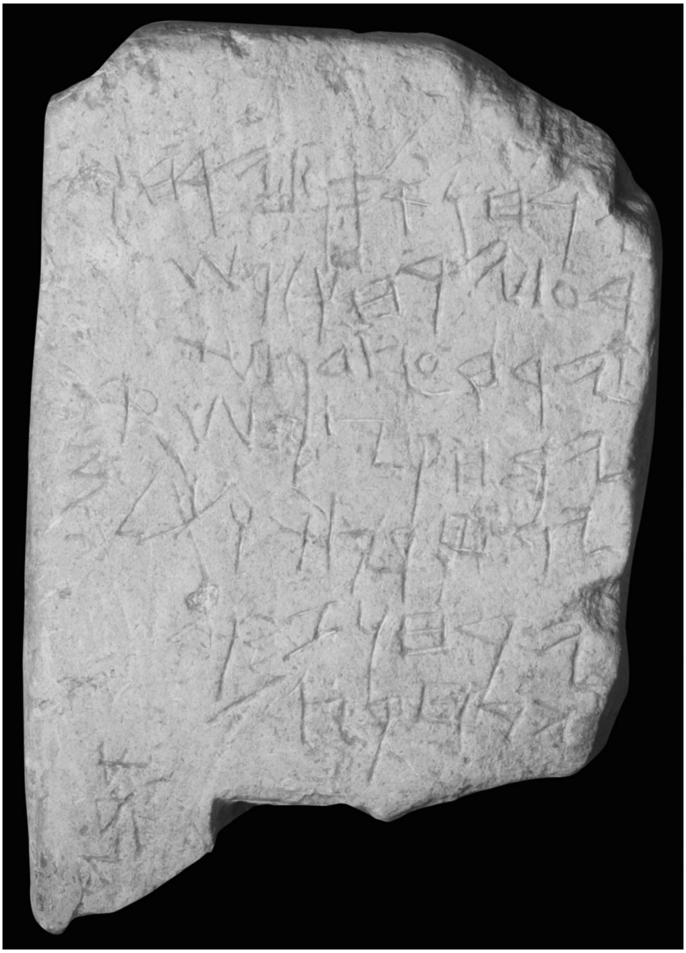

The "Gezer calendar," a tenth century B.C.E. limestone tablet discovered in 1908 in excavations of the Cannanite city of Gezer, 20 miles west of Jerusalem. It lists, in paleo-Hebrew, the months named according to their agricultural activities; for example, month 4 (late winter/early spring) is called ירח קצר שערמ, month of the barley harvest. The scribe's name is given as אביה, Abiyah. (Courtesy of the Istanbul Archaeological Museums, Istanbul.)