INTRODUCTION

The traditional *ordo* for A.D. 2001 bears the following caption beneath the header on the first page:

Littera Martyrologii: e, Littera Dominicalis: g,
Epactæ: v, Aureus numerus: 7, Indictio Romana: 9

Sadly, owing to the crisis in the Catholic Church many laymen, seminarians and even priests do not know, or know very imperfectly, what these words, letters, and numbers mean. They are, of course, essential to the calendar for the Roman liturgy, and behind them lies significant intellectual and ecclesiastical history. This monograph represents an outline of the history, mathematics, and operation of the ecclesiastical calendar. Its chief aim is to enable the traditional Catholic to understand and use all the columns of the *Kalendarium* in the *Roman Missal* and the *Roman Breviary* as well as to understand the *Luna* of the *Roman Martyrology*. To be sure, this monograph contains a great deal more information than is necessary in order to use the Church calendar. However, the objective is to offer a solid introductory grounding in the history and mechanics of the ecclesiastical calendar. Therefore, the reader should be guided by the advice of the Book of Proverbs (iv: 7) *et in omni possessione tua, acquire prudentiam*.

EASTER

1. To understand the ecclesiastical (and civil) calendar, we must start not with the reform of Julius Cæsar but with the history of Easter. In the Bible, the day on which the Passover or *Paschal* lamb was slaughtered took place on the 14th of the Jewish month Nîsân (April-March), which was the first month of the Mosaic religious year. Since 14 Nîsân is the 14th day of a lunar month, the full moon occurs on that day. In addition, this Paschal full moon must be the first full moon after or on the vernal (spring) equinox, when day and night are of almost equal length. Of course, it may fall on any day of the week. According to St. John, our Lord was crucified on 14 Nîsân.

2. In the early years of Christianity, the churches in Asia Minor celebrated Easter on 14 Nîsân; inasmuch as they kept Easter on Passover day, they were called Quartodecimans (or "Fourteenthers"). However, churches in the West celebrated Easter on a Sunday after the vernal equinox. By the end of the 2nd century, Pope St. Victor I (A.D. 189-98), and most bishops, insisted on observing Easter on a Sunday following 14 Nîsân.

3. As a result of the Council of Nicæa (A.D. 325), the Church eventually established the rule, or canon, for finding Easter. In order to make the time of Easter independent of longitude (i.e., the time zone), the Church adopted a *notional* (theoretical) full moon as well as a *notional* date for the vernal equinox so that actual observation of the astronomical full moon would be unnecessary. (The astronomical definition of the vernal equinox gives a precise *time*, not a calendar date, viz., the time at which the apparent longitude of the sun is zero degrees.) The canon specified that Easter should fall on the Sunday following the Paschal (notional) full moon occurring on or after the vernal equinox (in 325, the astronomers thought that the equinox occurred that year on March 21). To avoid a chronological absurdity, later jurists insisted that Easter, the feast of the Resurrection, occur *after* Passover. Therefore, the rule was expanded to require that if 14 Nîsân occurs on a Sunday, then Easter falls on the next Sunday. The formula for Easter is usually now expressed as *the first Sunday after the first full moon on or after the vernal equinox, the full moon being the 14th day of the new moon, the new moon having aged 13 days and the vernal equinox being March 21.*

4. Under this formula, the date of Easter is difficult to calculate. The council did not define the formula but assigned that task to the Church at Alexandria, which each year had to announce to Rome, through the *Paschal Table,* when Easter was to be celebrated. The civil calendar was and is solar (based on the sun), but the calculation of Easter is lunar (based on the moon). The Alexandrians had to find a simple method to calculate days of the week in any year and to determine dates of full moons in any given year.

FUNDAMENTAL CALENDAR ASTRONOMY

5. Lunar and solar calendars are, however, incommensurate. To correlate the lunar month to the solar year, the Alexandrians created a *lunisolar* ecclesiastical calendar by adopting the *Metonic* (or *Metonian*) *cycle,* devised around 433 B.C. by Meton of Athens and Euctemon, who doubtlessly based their work on that of the Babylonian calculators. To understand the problem then and later with the Gregorian reform, a little basic astronomy is needed.

6. The lunar or synodic month (sun-earth-moon alignment at full moon) is almost 11 days shorter than the solar, or mean *tropical,* year. The mean tropical year is determined by averaging the sun's longitude over the entire orbit of the earth; it describes the sun's *apparent* annual motion north and south, and is often defined inaccurately as the interval between successive passages of the sun through the vernal equinox.

7. The synodic, or ordinary, month has an average interval of 29.53059 (or about 29½) days; a lunar year contains 12 X 29.53059 or 354.3671 days. The tropical year in A.D. 2000 averaged 365.24219 (or about 365¼) mean solar days (incidentally solar years grow *shorter* as time passes). Notice that neither the solar nor the lunar year has a complete number of days. Accordingly, if a calendar is to keep in step with the moon's phases, days must be inserted to reconcile, or connect, the synodic month to the tropical year.

8. The Metonic cycle removed the 11- (actually 10.875-) day difference by the insertion (*intercalation* or *embolism*) of additional months in certain years of the cycle. To keep the months in whole days (after all, in practice we could never imagine a calendar with half or quarter days), Meton and Euctemon (**§5**) devised a long-term, fairly accurate rule.

19-Year Metonic Cycle

9. The rule is as follows:

12 common years of 12 lunar months each

+7 embolismic years of 13 lunar months each

19 years with a total of 235 lunar months, or lunations [(12 X 12) + (7 X 13)= 144 + 91 = 235, of which 110 are hollow (29-day) months, and 125 are full (30-day) months]

To appreciate the accuracy of Meton's cycle, compare it with the normal civil calendar year, which consists of 365 whole days: 365 days X 19 years = 6,935 days. As explained above, the 19-year Metonic cycle consists of 235 lunations made up of 110 hollow and 125 full months: (110 months X 29 days) + (125 months X 30 days) = 6,940 days. Thus there is only a difference of five days (6940−6935) in 19 years between the Metonic cycle and the ordinary calendar. But if we divide the days in the Metonic cycle by the 19 years in the cycle (6940 ÷ 19), the result is 365.26316 (about 365¼) days for the length of the year — a number very close to the current tropical year of 365.24219 days (**§7**). The singular advantage of the Metonic cycle was that it (a) established a lunar calendar with a definite rule for inserting intercalary months and (b) kept that calendar in step with the tropical year.

10. The Metonic cycle may be improved by further intercalation to be in harmony with the 365¼-day Julian year, established in 45 B.C. Common years may be divided into 6 hollow (29-day) and 6 full (30-day) lunations, and 6 of the 7 embolismic years also may have a similar complement of 29- and 30-day lunations. Thus (19 X 6 X 29) + (19 X 6 X 30) + (6 X 30) + 29 = 6,935, which is the same result as 19 X 365 (**§9**), the number of days of a 19-year period of "natural" civil days. However, since the Julian calendar adds a leap day every fourth year, then 19 X 365.25 = 6,939.75 days. Subtracting 6,935 civil days from that result yields a 4.75-day difference. Thus the improvement to the Metonic cycle (a) accommodates the insertion of a leap day every four years into whatever lunation contains February 24 (**§§26-27**) and (b) brings the cycle into complete harmony with the Julian calendar (6,939.75 ÷ 19 = 365.25).

THE DIONYSIAN CANON

11. From A.D. 328, St. Athanasius, the bishop of Alexandria, published Paschal letters for all the Church to use, in which he announced the date of Easter based on the Metonic cycle. However, because the Romans did not know how to operate the complex cycle, the date of Easter sometimes differed in Rome and Alexandria. Therefore, tables of dates were prepared to enable Roman *computists* (**§20**) to calculate the date of Easter accurately.

12. After two crises, St. Hilarus of Rome (later Pope) asked the bishop of Acquitaine, Victorius, to examine the reasons for the difference beween Rome and Alexandria. In 457, Victorius drew up tables based on his discovery that Easter dates, according to the Alexandrian canon, repeat every 532 years (19 years X 7 days a week X 4-year leap year interval). This period is called the *Great Paschal* because it interlocks, or combines, the lunar (19-Julian year) and solar (7 X 4 = 28 year) cycles.

13. The last Alexandrian tables sent to Rome were to expire in A.D. 531, so in 525 Pope St. John I asked the Scythian abbot and canonist Dionysius Exiguus (Denis the Little) to modify the Alexandrian computation. Dionysius based the new chronology on the Great Paschal of Victorius. Using the Metonic cycle, he devised the *Dionysian Canon* to calculate the date of Easter. The canon lasted 1,000 years (and, for all practical purposes, is in effect today [**§§20-28**]).

14. Dionysius knew that in the year after the Alexandrian tables expired the date of the vernal equinox was also the date of a new moon. This happy coincidence suggested that A.D. 532 should be the first year of a new Great Paschal cycle of 532 years (**§12**). Working backward, he found a new moon had occurred on January 1, 325 (the year of the Council of Nicæa [**§3**]), so his instincts seemed confirmed.

15. Working back to the first year of the cycle, he found 1 B.C. also to be an apropos year because he thought that the Annunciation occurred on March 25 of that year. (Many scholars, with a new interpretation of the chronology of Clement of Alexandria – the same source Dionysius used – now believe that our Lord was born in 3/2 B.C.) Therefore, according to Dionysius, the year of birth was 1 B.C.; the first full year of Christ's life then began January 1, A.D. 1. Thus, it may be said that Dionysius "invented" the Christian era, although he did not originate the era markers B.C. and A.D. (As a usage note, A.D., the abbreviation for *Annô Domini,* i.e. "in the year of our Lord," must be placed *before* the year, not after it: 2002 A.D. may be common today, but it still must be considered illiterate.)

The Need for Reform

16. The Julian calendar, however, runs slow against the sun's tropical year (**§§7** & **10**) by one day every 128.2 years, as illustrated below:

The difference between the measure of the years:
Julian Year: 365.2500
Tropical Year – 365.2422
.0078

Number of years that must pass to accumulate one day's difference:

$$\frac{1}{.0078} = \mathbf{128.2}$$

By the beginning of the Council of Trent (1545-1563), 1,220 years had passed since the council of Nicæa (**§3**). Thus

$$\frac{1{,}220}{128.2} = \mathbf{9.5} \text{ Days Error}$$

Recall that the Church earlier had defined the vernal equinox as March 21 (**§3**). However, in the 16th century the accumulated error of almost ten days meant that the vernal equinox was occurring on Julian calendar date March 11 (ten days behind or *slower*). In order to stabilize the vernal equinox, a solar correction was necessary.

17. *As an aside, the Julian calendar also runs slow against the 19-year cycle of the moon. The Julian year assumed 235 lunations in a 19-year cycle, or exactly 6,939.75 days* (**§10**). *However, if we multiply 235 by 29.53059, the number of days in the synodic month* (**§7**), *the result is 6,939.68865. Now the Julian decimal portion .75 = 18 hrs, and the synodic decimal .68865 = 16.5 hours. The difference means that the new moons of a new cycle are about 1½ hours earlier than those in the previous cycle; the new moons were said to "slip" by about one day every 310 years: 19 X (1 ÷ [.75 − .68865]) = 309.7. By 1545, a lunar error of almost four days had accumulated since Dionysius's A.D. 532* (**§§13-14**). *The error may not seem too severe except that in some years Easter would be wrong according to both the sun and the moon* [**§18**].

THE GREGORIAN CALENDAR & EASTER

18. The Council of Trent authorized the needed reform, and on February 24, 1582, Pope Gregory XIII issued the bull *Inter gravissimas*. To correct the vernal equinox, Gregory ordered that the day after the feast of St. Francis be designated October 15 (omitting the 10 days from October 5-14). To bring the calendar year in line with the shorter solar year, Gregory declared three out of four centennial, or century, years to be common or non-leap; only centuries divisible by 400 would be considered leap years. The correction thus made the average length of the year to be 365.2425 days (365 + ¼ – [3 ÷ 400]), a period much closer to the mean tropical year we now know (**§§6 & 7**) and very close to the current vernal-equinox year of 365.2424 days. (The Gregorian lunar correction [**§17**] subtracted 8 days every 2,500 years [1 day every 300 years for 7 intervals + 1 interval of 400 years, assumed to have occurred between A.D. 1400 and 1800] to reduce the mean period of notional lunations by shifting the new moons to an earlier date. The Gregorian correction for the moon is 365 + ¼ – [8 ÷ 2500], yielding an approximate Metonic year of 365.2468 days.)

19. Although the Gregorian calendar *in practice* does not use methods different from those employed in the Julian-Alexandrian-Dionynisian scheme for finding Easter, underlying the Gregorian construction is a very different method of arriving at new moons or new months. The old canon relied on the system of *Golden Numbers*, from 1 to 19 for any given year, to obtain the full moon date for the calculation of Easter Sunday for the given year. The Gregorian system derived the moons *indirectly* from a quantity called an

epact, which is the "age" of the moon on January 1, or March 1, for they are the same (**§29**). However, liturgical books continued to print the Golden Number.

The Golden Number

20. The technical term for finding Easter is *computus*, and the following paragraphs detail how to compute Easter for any year according to the pre-Gregorian method. (It still works.) In both the Gregorian and Julian calendars, each year in the 19-year Metonic cycle (**§8**) of common and embolismic months has a unique number called the *Golden Number* (*aureus numerus* in the traditional *ordo* [**Introduction**]), which simply places the year under consideration within the 19-year cycle. The Golden Number provides commensurability between the religious lunar calendar and the tropical year; in essence, its purpose is to find the notional Paschal full moon (**§3**), since every 19 Julian-calendar years, the full moon falls on the same day. (Often the Golden Number is written as a roman numeral.) To compute the Golden Number for a year, using long division (by hand, do not use a calculator!), first divide the year by 19. Then take the remainder (do not use a decimal remainder) and add 1 to obtain the year's Golden Number. (Remember that Dionysius [**§15**] used 1 B.C. as his origin: the concept of "zero" had not been invented in his day; thus we must add 1.)

21. For example, take the year A.D. 1918. Divide by 19, and the remainder is 18. Add 1, and thus the Golden Number is 19. (Alternately, one may, of course, add 1 to the year before dividing by 19; but if the remainder is 0, as it is in this case, then the Golden Number must be 19.) Both Julian and Gregorian years will always have the same Golden Number; in the Gregorian system, however, each Golden Number will have associated with it a unique epact (**§§19** & **29**).

Dominical Letters

22. After calculating the Golden Number, next find the Dominical (Sunday) Letter for the year. The Dominical Letter indicates what days are Sundays during the year; in other words, the Dominical Letter determines the possible Sundays for celebrating Easter. Each Dominical Letter also has corresponding Dominical Number (**§48**). It is important to study the operation of Dominical Letters in order to understand their application in the *Roman Missal*, the *Roman Breviary*, and the *ordo*. Each year has its own Dominical Letter *(littera dominicalis* in the traditional *ordo* [**Introduction**]), and a leap year has two Sunday letters [**§26**]).

23. The ingenious letter system allocates sequentially to every day of the year the seven letters A-G: January 1 = A, January 2 = B, January 3 = C, January 4 = D, January 5 = E, January 6 = F, January 7 = G, January 8 = A, January 9 = B, etc. through the last day of the year, December 31, which is always A — the same as January 1. (The succeeding year must begin on a different weekday because 365 ÷ 7 is not an even number.) In a leap year, February 24 and 25 are both marked F (**§26**). (In the traditional *Roman Missal* and *Breviary*, the *Kalendarium* [**§44-47**] displays the calendar letter for every day of the year.) Now the first day of every month, whatever the year, begins with the same letter: knowing the calendar letters and the Dominical Letter of the year enables almost anyone to derive the day of the week on which any date in the year falls.

24. The following couplet is a useful mnemonic device to remember the letter of the first day of each of the 12 months of the year:

***A**t **D**over **D**well **G**eorge **B**rown, **E**squire,*
***G**ood **C**hristopher **F**inch **A**nd **D**avid **F**riar.*

At = January, **D**over = February, etc. In order to find the day of the week on which, say, April 9, 1999, fell, first use the above rhyme to find the letter of April 1 (the fourth month, so the fourth word ***G****eorge*, letter **G**). Next, write down in a row the letters A B C D E F G. Then, beginning with G (April = **G**eorge = G), start counting inclusively (**§40**) with G through the seven letters until you arrive at the letter corresponding to 9: G=1, A=2, B = 3, C=4, D=5, E=6, F=7, G=8, A=**9**, or as illustrated in the table below:

						1
A	**B**	**C**	**D**	**E**	**F**	**G**
2	3	4	5	6	7	8
9						

To derive the weekday for April 9, you must first know the day of the week on which January 1, 1999, fell (always letter A, **A**t). January 1, 1999, was a Friday, so April 9 (=A) was a Friday. You may also start with the Dominical Letter for 1999, which was C: working backward, since C is the letter for the first Sunday, then B was Saturday, and A was Friday.

25. To find the Dominical Letter for any year, you may inspect a *Tabella Temporaria* in a Missal or you may use a *perpetual table*, such as that found in the *Roman Missal* or *The Oxford Companion to the Year* or you may calculate it (**§48**). (The *Missal*'s perpetual tables [**§48**] are arranged with 28-year differentials because the cycle of Sunday letters repeats every 28 years [7 days a week X 4-year interval for leap years = the 28-year solar cycle {**§12**}].)

26. As observed in **§22**, leap years have **two** Dominical Letters — the first for January and February and another for the remaining ten months. The intercalary day (the day added or inserted in the leap year) has no letter of its own, but shares the letter F (**§§23** & **27**). The technical name for a leap year is a *bissextile* year. According to the ancient Roman method for reckoning dates (**§§39-41**), which the Roman Catholic Church officially uses in its *Kalendarium* (**§44-47**) in addition to the month-and-day system we all use, in a common year, February 24 is the sixth day before March 1, counting inclusively (**§40**). Since the Middle Ages, in the Roman Catholic calendar, the intercalary day has been generally presumed to occur before February 24. In a bissextile year, then, there are two "sixth days" before March 1 or two February 24's: the first, the leap day *a.d.* ***bis*** *vi Kal. Mart.* ("the ***twice*** sixth day before March 1") and second, the common day *a.d. vi Kal. Mart.* "the sixth day before March 1." Although the traditional Roman Catholic calendar acknowledges a 29th day in a leap year, the Dominical Letter changes on February 24, not on February 29. The term leap year comes from the 1604 Anglican *Book of Common Prayer*, which observed that "every four years the Sunday letter leapeth." The letter "leaps" or changes to the preceding letter in order to allow the first of each remaining month of the year to begin always with the same calendar letter (**§24**). In other words, leaping restores the system so that we can find the day of the week for any date. For instance, the year A.D. 2000 was a leap year (a century year divisible by 400 [**§18**]) with Dominical Letter **B** for January and February and **A** for the rest of the year. Likewise, if the first Dominical Letter of a leap year were **A**, then the second would be **G**; if **D** then **C** etc. Since Easter can fall between March 22 and April 25, the **second** Sunday letter is needed to find Easter Sunday in a leap year.

27. As shown in **§§23** & **26**, calendar letters are restored by assigning to February 25 the same letter as February 24, viz. **F**, so that March 1 will remain **D** (***D****well,* **§24**). In so doing, however, two

feast days are affected. Below is the relevant portion of the ecclesiastical calendar for a common (non-leap) year:

Letter	Day Before Mar. 1 (Roman)	Feb.	Feast
D	8th	22	St. Peter's Chair
E	7th	23	St. Peter Damian
F	6th	24	St. Matthias
G	5th	25	
A	4th	26	
B	3rd	27	St. Gabriel/Dolors BVM
C	Day Before Mar. 1	28	

The day before March 1 (February 28) has letter **C**, so March 1 will have **D** as it should. In order to keep **D** as the letter for March 1 in a bissextile year, February 25 shares its letter (**F**) with February 24:

Letter	February
F	24
F	25
G	26
A	27
B	28
C	29
D	**March 1**

In a bissextile year, the feast of St. Matthias is celebrated on February 25 and that of St. Gabriel of the Dolors of the BVM on February 28. The reason is to make sure that St. Matthias' Day will not be the "***twice*** sixth" but will remain "the sixth" day before March 1, i.e. February 25 in a leap year (for February 24 would be the "twice sixth" day). The same reason applies to the transfer of St. Gabriel's feast day: the Church wanted to keep the same Roman-style date, viz., the "third day before March 1," or *a.d. iii Kal. Mart.* (see **Roman Days**, **§§39-41**).

28. In the Julian calculation of Easter, after determining the Golden Number and Dominical Letter for a year, the computist referred to a table (like that still printed in the English prayer book) and located the date of March or April (Easter may fall as early as March 22 and as late as April 25 [**§26**]) that corresponded to the Golden Number. The identified date was that of the Paschal full moon. Then the computist read down a column of numbers until he found the Dominical Letter that corresponded to the date of Easter Sunday. To illustrate: for 1918, we calculated (**§21**) a Golden Number of 19. Rather than trying to find an old *ordo* or a 1918 calendar, we can use the 1901-2100 Dominical-Letter table (**§48**) in the *Missal* (or calculate directly [**§48**]) and learn that the letter for 1918 was **F**. Next we can refer to a table like the partial one printed below (in practice, of course, it would extend to April 25):

GN	MARCH	DL
14	22	D
3	23	E
	24	F
	25	G
	26	A
19	**27**	B→→→↓
8	28	C ↓
	29	D ↓
16	30	E ↓
5	**31**	**F**←←←←

In the first column, we find the Golden Number (**GN**) 19 and know that the date of the Paschal full moon was March 27 (second column). Moving to the Dominical Letter (**DL**) column, starting with **B**, which is opposite March 27, we look down the column until we encounter the Dominical Letter for 1918, which we know from the Sunday-Letter table (or by calculation, **§48**) is **F**. We then read the date of Easter from the second column (March 31).

The Epact

29. Although the date of Easter may be found under the Gregorian system by using the Golden Number and Dominical Letter as in the Julian system, the Gregorian calendar reform derives moons

from the *epact* (**§19** & *epactæ* in the **Introduction**), the excess days of the solar year over the lunar year, or in effect the "age" (or phase) of the moon on January 1 (and March 1, too, for it is the same). The new moon occurs every 29.53 days (once in a synodic month [**§§6-7**]), when its illuminated crescent, as seen from earth, appears to have almost disappeared. Its age is 0 (or 30 in a 29-day lunation), and is marked ***** in the *Missal* tables because 0-age would be counterintuitive. The age of the notional full moon then is 13 days. (Actually, an epact is the age of the moon, diminished by one day.) From the rules for constructing a lunar calendar, a table may be drawn up to yield the epact, which varies between 0 and 29 (a total of 30).

30. The epact may be calculated directly. For the 20th and 21st centuries, the formula is

$$\frac{11(GN-1)+8+(-9)}{30}$$

where GN = the Golden Number of the year in question. For example, for 1998, GN = 4:

$$\frac{11(4-1)+8+(-9)}{30}$$

$$\frac{41+(-9)}{30}$$

$$\frac{32}{30}$$

The remainder 2 = the epact of the year.

31. Once you know the epact of the year you can find the March new moon, which is the key to finding Easter. The March new moon = 31 minus the epact of the year. For 1998, the new moon occurred on March 29 (31 minus 2). Since March 29 must then = 0, the Paschal full moon, the 13th day, fell on April 11. We could have arrived at the same result using the Golden Number and a prepared table as in **§28**, which continues:

GN	**APRIL**	**DL**
…	…	…
4	11	C
	12	D
12	13	E
1	14	F
	15	G
9	16	A
17	17	B
6	18	C
	19	D
…	…	…

(**N.B.** There are **no** Golden Numbers indexed to the dates of April 19 - April 25.)

Thus, although we may use the Golden Number to determine the epact, we can still arrive at the date of the Paschal full moon by simple subtraction and counting. *This is the Gregorian advantage: We may dispense with a lunar table.* To find Easter Sunday, determine the Dominical Letter from a table, *ordo* (**§25**), or by calculation (**§48**) and then compute directly by using the technique in **§24** to ascertain the day of the week on which April 11 falls (April 1 = **G** for ***G****eorge*). Next count over to Easter Sunday. In 1998, the Dominical Letter was **D**. As you see below (and above, too), the calendar letter for the Paschal full moon falling on April 11 was C, so Easter fell on the 12th.

						1
A	**B**	**C**	**D**	**E**	**F**	**G**
2	3	4	5	6	7	8
9	10	*11*	**12**			

32. There is a rule to predict the epact of the next year. The epact increases 11 days for each succeeding year until it exceeds 30; at that point, 30 is subtracted and the remainder is the epact, for in essence an embolismic month has been inserted; note, however, that the epact increases by *12* when we move *from* Golden Number **19** *to* Golden Number **1**. (The omission of

a day at the end of each Metonic cycle [**§§5-10**] so as to keep pace with the sun is called the *saltus lunæ*, or *leap of the moon*.) In 1998, the epact was *2*; in 1999, it was *13*; in 2000, it was *24*; in 2001, it was *5* (24 + 11 − 30); in 2002 it was *16* (5 + 11).

33. Occasionally, however, an adjustment must be made to the epact in order to obtain successive Paschal terms as defined by the canon of Dionysius (**§13**). The *Paschal term* = the date of the new moon + 13, with Easter on the Sunday after the 14th *Luna* of the lunar month of spring (**§§1, 3,** & **29**). Also, as may be seen from the tables in **§§28** & **31**, a Golden Number is indexed only to *some* of the dates in March and April; the indexing requires that epacts of certain Golden Numbers be followed by a specific Paschal term.

34. To illustrate the problem, consider the year A.D. 2000, Golden Number 6, Dominical Letters B/**A** — a century leap year divisible by 400 (**§§18** & **26**), and epact 24. First determine the March new moon (**§31**), which is March 31 – 24 = March 7. Next, *attempt* to find the Paschal full moon: March 7 + 13 = March 20. However, March 20 falls *before* the notional vernal equinox of March 21 (**§3**), and thus cannot be the date of the Paschal full moon. Therefore, add 17 (13 + 17 = 30, the number of days between consecutive lunations) to find the next new moon: March 20 + 17 = April 6, and then add 13 to find the Paschal full moon of April 19. *But now the problem is that there is no Golden Number indexed to that date in the Paschal term, as the table in* **§31** *shows.*

35. The solution to keeping the length of the Paschal term constant is to tighten up the Golden Numbers by the device called *second epacts*. The new moon is pushed back a day by increasing to 25 the calculated epact 24 for A.D. 2000. To illustrate the operation of the second epact: March 31 – 25 = March 6, the March new moon. Next find the Paschal full moon: March 6 + 13 = March 19. Of course, March 19 falls before the notional vernal equinox of March 21 (**§3** & **33**), and thus cannot be the date of the Paschal full moon. Therefore, to find the next new moon add 17 (13 + 17 = 30), the number of days [**§29**] between consecutive lunations ([**§§6** & **7**): March 19 + 17 = April 5, and then add 13 to find the Paschal full moon of April 18. That date in the Paschal term is indexed to Golden Number 6 (see table in **§31**).

36. Another adjustment, or tightening up, occurs when the Golden Number is greater than or equal to 12. This adjustment preserves the Julian property that the Easter moon never repeats within a 19-year cycle. In the case of A.D. 2000, the Paschal full moon date will repeat 11 years later when the adjustment in **§35** is made, as in A.D. 2011. In the latter year, Golden Number 17, the calculated epact 25 gives a new moon on April 5 and hence a Paschal full moon on April 18, exactly as in 2000! By increasing the epact by 1 to 26 in such a year (i.e., by fictionally equating the calculated epact 25 to 26), the adjusted new moon is pushed back to April 4, and the Paschal full moon then occurs on April 17, thereby preserving the Julian property.

THE ROMAN MARTYROLOGY

37. The epact must be known in order to read the *Luna* of the *Roman Martyrology*, which is sung (or laudably recited) at Prime, just before the *Pretiosa*. Prime is the Church's morning prayer, so it is fitting to pronounce both the solar calendar date and the age of the moon in the current lunar cycle. Therefore, every year is assigned a *Martyrology letter*, which is related to the epact. Every day of the year in the *Martyrology* shows, under the *Martyrology*

letter for the year, the *Luna*, or the ordinal number of the day in a lunar month (i.e., in a lunation). For example, below is a sample heading from the *Martyrology* (for Christmas). Note that the modern-style date of (December) 25 appears on the left, the date according to the Roman system (**§39-42**) in the center along with the keyword *Luna* (to which will be added the number of the lunation, as an ordinal), and at the right the calendar letter for the day (**§23-24**) followed by the epact for that day as given in the *Kalendarium* of the Church *(provided the new moon were to fall on that day* [**§44**]*)*.

25 Octavo Kalendas Januarii. Luna. B xxvi

a	b	c	d	e	f	g	h	i	k	l	m	n	p	q
6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
r	s	t	u	A	B	C	D	E	F	F	G	H	M	N	P
21	22	23	24	25	26	27	28	29	30	29	1	2	3	4	5

Thus in 2001, the *ordo* supplies the Martyrology letter *e* (note the lower-case); underneath *e* is the corresponding numeral *10*. Therefore, December 25, 2001, is the tenth day in the lunar cycle, or *Luna décima*.

38. To understand the relationship of the Martyrology letter to epacts (and, of course, to Golden Numbers [**§20**]), first inspect a Gregorian epact table indexed for 1900, 2000, and 2001-2100:

GN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Epact	29	10	21	2	13	24	5	16	27	8	19	*	11	22	3	14	25'	6	17

For 2001, under Golden Number 7, the epact is 5, or v as written in liturgical books. Now, examine the *Martyrology* table for the year, which is found at the beginning of the *Martyrology* (epacts are written in small roman numerals beneath the *Martyrology letter*):

a	b	c	d	e	f	g	h	i	k	l	m	n	p	q	r	s
i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	xii	xiii	xiv	xv	xvi	xvii
t	u	A	B	C	D	E	F	**F**	G	H	M	N	P			
xviii	xix	xx	xxi	xxii	xxiii	xxiv	xxv	**25**	xxvi	xxvii	xviii	xxix	*			

Epact 5 (v) corresponds to the *Martyrology letter* ***e***, the letter for 2001 (**Introduction** & **§36**).

ROMAN DAYS

39. As mentioned in **§§27** & **36**, the Church continues to use the Roman system of dating along with the modern method. The Roman method differs from the modern system, (which counts *forward* from the first of the month) by counting *backward* from three marker-points in each month: **Kalendæ** (Calends, abbreviated **Kal.**), falling on the first day; **Nonæ** (Nones, abbreviated **Non.**), falling in eight months of the year on the fifth and in four months of the year on the seventh day; and **Idus** (Ides, abbreviated **Id.**), falling in eight months on the thirteenth and in four months on the fifteenth day. (The Ides represented the day of the full moon in the old, pre-Julian Roman calendar.) Learn the following quatrain to remember when the Ides and Nones occur:

> *In March, July, October, May,*
> *The Ides fall on the fifteenth day,*
> *The Nones the seventh; but all besides*
> *Have two days less for Nones and Ides.*

40. Days of the month were reckoned backwards as so many days before the Calends, Nones, or Ides, and the Romans reckoned *inclusively*. Inclusive reckoning includes the first and last day as part of the count, unlike the modern system of *exclusive* reckoning that omits the first day. (Between the 10th and the 15th of March, we moderns count five days [*11*, 12, 13, 14, *15*]; the Romans, however, counted six days [*10*, 11, 12, 13, 14, *15*]). To indicate the day before one of the markers, the Romans wrote *pridie* (abbreviated *Prid.* in the *Kalendarium* [**§44-47**]).

41. The names of the Roman months were actually adjectives modifying the three marker points. (Modern English

month names so closely resemble the Latin names that there is no need to give the Latin forms here; for more information about the months and the entire Roman system, the reader should refer to a Latin grammar book or the *Oxford Companion to the Year*.) The Roman system originally used an idiomatic phrase unit in the accusative case to express the formula for the *so many-eth day* before the Calends, Ides, or Nones. Romans began with *ante diem* (abbreviated *a.d.*); then they expressed the number of days before the marker by an ordinal number (abbreviated by lower-case roman numerals); finally they indicated the marker day, which was followed by the month adjective. Thus March 5 (March Nones fall on the 7th) = *ante diem tertium Nonas Martias (a.d. iii Non. Mart.)*, the third (*not* the second) day before the Nones of March (March 5, 6, and 7). April 14 = *a.d. xviii Kal. Maj.* (the Ides of April fall on the 13th, so one must count backward from the next marker point — the Calends of May).

42. Even in Roman times, it was usual to omit the *ante diem* and change the ordinal from the accusative to the ablative case. In the Middle Ages, the month was treated as a noun in the genitive case. For the most part, the Church has adopted these small modifications in its liturgical books. Thus May 5 is written *iii (=tertio) Nonas Maji* rather than *ante diem tertium Nonas Majas (a.d. iii Non. Majas)*. Under the Church's system, Ides is abbreviated **Idib.**, for the ablative *Idibus*.

THE ROMAN MISSAL

43. Priests of the Roman rite are bound under grave obligation to celebrate the Mass and recite the prayers of the Divine Office appointed for each calendar day of the ecclesiastical year. Accordingly, the *Roman Missal* and *Breviary* as well as the *Martyrology* (**§37-38**) contain detailed information and tables related to the calendar. To be sure, in practice, the *ordo* (**Introduction**), the annual calendar with instructions for Mass and the Office, relieves the priest of the need to perform the calculations, consult the tables, and make the inferences necessary to say the Office or celebrate Mass rightly. Nevertheless, the various computational tables constitute a material part of the Church's principal liturgical books. Both the *Missal* and *Breviary* print the Church's Universal calendar.

The *Kalendarium*

44. The *Kalendarium* of the Universal Church lists the feasts to be celebrated and their degree, or relative solemnity, for each day of the year. There are four columns that precede the name of the feast. The first (from the left) exhibits the cycle of epacts — *Cyclus Epactarum* (**§§29-36**) — in small roman numerals. The epact figure in the first column corresponds to the day of the month (*Dies Mensis*) in the fourth column on which a new moon falls in a given year. In March, the epact added to the day of the month = March 31. For example, in **§31** we found that for 1998 a new moon occurred on March 29; the cycle of epacts for (March) 29 is **ii**, which is the epact for year 1998. As another example, the epact of 2001 (**Introduction**) was **v**; thus to find the March new moon of 2001, look in the fourth column (**§47**) of the *Kalendarium* at (March) 31 and trace backward in the cycle-of-epacts column until you encounter **v**, which is indexed to (March) 26. Count 13 days forward (exclusively since March 26 = the new moon = 0), and you will obtain (April) 8 as the day of the 1998 Paschal full moon (**§§1-3** & **31**). The *Martyrology* (**§37**) employs the same system for epacts. The epact column displays the symbol ***** (**§29**), not a number, to identify the epact of January 1 when the moon is 30 days old on December 31. The last new moon of epact ***** is December 21.

45. The second column from the left in the *Kalendarium* gives the Dominical Letter — *Littera Dominicalis* — for each day of the year (**§§22-27**). Continuing with the last example in **§44**, in the *Kalendarium*, the Sunday Letter for April 8 is **g**, and for 2001 the Sunday letter was **g** (**Introduction**). The reader therefore knows that the Paschal full moon for 2001 fell on a Sunday. By rule (**§3**), if the Paschal full moon (= 14 Nîsân [**§§1-3**]) occurs on a Sunday, Easter falls on the following Sunday, which in 2001 was April 15 (with Dominical Letter **g**).

46. The third column from the left provides in the form of small roman numerals or of abbreviations the marker point for the Roman date (**§§39-42**) associated with the day of the month. (March) 26 reads **vii**, i.e., *ante diem septimum Kalendas Apriles* or *septimo Kalendas Aprilis*, "the seventh day before the first of April."

47. The fourth column records in arabic numerals the number of the day of the month — *Dies mensis* — according to the modern practice (**§39**).

Table of Dominical Letters

48. The *Missal*'s Sunday-Letter table for 1901-2100 is arranged according to the 28-year solar cycle (**§§12** & **25**), as seen below.

f	**e**	**d**	**c b**	**A**	**g**	**f**	**e d**	**c**	**b**	**A**	**g f**	**e**	**d**
c	**b A**	**g**	**f**	**e**	**d c**	**b**	**A**	**g**	**f e**	**d**	**c**	**b**	**A g**

Each cell represents a year, 1901 starting with the first cell at the top left containing **f**. The 28th cell at the bottom right is 1928, a leap year with letters **A** and **g**. The next cycle recurs with 1929 at the top left, **f**, and ends at the bottom right, **A g**, 1956. It then repeats itself with 1957 at the top left, **f**, etc. The cycle at this writing begins with 1985 (**f**) and ends in 2012. The next 28-year cycle will begin the first cell (**f**) with the year 2013. (The table is valid to the year 2100 exclusively.) To find the Dominical Letter for 2007, count exclusively to the 22nd cell (2007 – 1985 = 22), to obtain **g**. *You may also directly calculate Dominical Letters for the years 1900-2099:*

(1) Divide the year by 4, ignoring any remainder: e.g. 2005 ÷ 4 = 501;

(2) Add the quotient to the number of the year and then subtract 1: thus, 501 + 2005 = 2506 − 1 = 2505;

*(3) Divide the result by 7; match the remainder (**R**) to its Dominical Letter (**DL**) in the table below (2505 ÷ 7 leaves a remainder of 6, thus the Dominical Letter is **b** for 2005) :*

R	0	1	2	3	4	5	6
DL	A	g	f	e	d	c	b

Gregorian Easter Table

49. The epact-driven Gregorian method is realized in the Missal's *Tabula Paschalis Nova Reformata* (Gregorian Easter Table), which lays aside the Golden Number system altogether (**§19**). The *Missal*'s perpetual table not only enables the user to identify Easter for any year for which the Dominical Letter and the cycle of epacts are known but also supplies dates for other movable feasts as well as the number of Sundays after Pentecost. In all, it is a very useful table. For the sake of space, below is reproduced a portion of the table for Dominical letter **g**, the Sunday letter as shown in the caption from the 2001 traditional *ordo* (**Introduction**). The entire table exhibits ten columns and eight rows, including the header.

Litteræ Domi-nicales	Cyclus Epactarum	Pascha
G	23. 22. 21. 20. 19. 18. 17. 16. 15. 14. 13. 12. 11. 10. 9. 8. 7. 6. 5. 4. 3. 1. * 29. 28. 27. 26. 25. **25**. 24	25 Mart. 1 Apr. 8 Apr. 15 Apr. 22 Apr.

The *ordo* gives epact **v**, which may also be calculated by the formula in **§30**. Use the column containing the cycle of epacts to determine the row containing epact **5** (the fourth line down), and look across to the *Pascha* column to obtain the date of Easter: April 15 (**§45**) for 2001.

Roman Indiction

50. The last number given in the traditional *ordo* (**Introduction)** is that of the *Indictio Romana*. The indiction is simply the number of a year in a 15-year cycle, and the formula is

$$\frac{\text{Year} + 3}{15}$$

with the remainder being the indiction: 2001 + 3 divided by 15 leaves a remainder of 9, as given by the *ordo* (**Introduction**). (If there is no remainder, the indiction is 15.) Indictions are not directly related to the calendar but to chronology, for they were used in Papal bulls, other public documents, and diplomatic writings. Use of the indiction began in A.D. 312 and ended in 1806 after Napoleon dissolved the Holy Roman Empire and Francis II abdicated. The *Missal* provides a perpetual table to pair an indiction with its calendar year.

EXERCISES

In the following exercises, show all work and narrate your line of reasoning.

- Calculate the current year's Golden Number and Epact.
- Using the Missal's table for Dominical Letters, identify the Dominical Letter for the current year.
- Determine the date of the March new moon for the current year.
- Determine the date of the Paschal full moon for the current year.
- Write the date of Easter for the current year in the Roman system.
- Using the Gregorian Easter table found in the traditional Missal, identify the days on which Septuagesima, Ash Wednesday, Easter, Ascension Thursday, Pentecost, and the First Sunday in Advent will occur in the current year.
- Calculate the indiction for the current year.
- Inspect the *Kalendarium* for the date 4 APRILIS; against that date in the column headed *Cyclus Epact.* examine the numerals **25** xxvi. In a short paragraph, explain their meaning.
- In the *Kalendarium*, under the column headed *Cyclus Epact.* against the date of 5 APRILIS, examine the numerals xxv and xxiv. In a short paragraph, explain their meaning.
- The epact for year 2011 is **25**, the Dominical letter **b**. Following the instructions in **§45,** we trace back from March 31 and find **25** indexed to March 6. We then count forward exclusively 13 days to March 20. Then, following the instructions in **§45**, we look for the day of the month corresponding to Sunday letter **b**, which the *Kalendarium* shows to be March 21. However, the date of Easter for 2011 is April 24. Explain.
- Using a traditional Missal's *Tabella Temporaria Festorum Mobilium* for the 20th or 21st centuries, examine the epact against Golden Number 19 and then explain why the epact is xxix, not xxviii, for Golden Number 1.
- Calculate the epact for 1995, and explain. Enter the epact formula in a spreadsheet, if you are perplexed: =MOD(11*(GN-1)+8+(-9),30).