

NATIONAL UNIVERSITY OF SINGAPORE

DEPARTMENT OF MATHEMATICS

SEMESTER 2 EXAMINATION 2005–2006

GEK1506 Heavenly Mathematics: Cultural Astronomy

April/May 2006 — Time allowed: 2 hours

Matriculation Number:

INSTRUCTIONS TO CANDIDATES

1. This examination paper contains 8 questions and comprises 12 pages including this page.
2. Answer all questions in this paper.
3. **Explain and justify your answers carefully.**
4. Answers and your matriculation number should be written on this question paper.
5. Candidates may use calculators.

1. After taking the Heavenly Mathematics class, you and your friend have decided to go on a round the world tour. You want to experience some of the interesting astronomical phenomena you have learned about in the class. However, your friend has not taken the class, so you will need to explain a bit. You and your friend have seen the Jackie Chan movie “Round the World in 80 days”, based on the book by Jules Verne. Your friend enjoyed the movie, but did not understand why the travelers had gained one day by traveling eastward. You want to explain this carefully, so you start by explaining the principle behind time zones. Fortunately you have a world time zone map. Your friend is really excited about your map and asks you a lot of interesting questions.

(i) *Why does Singapore seem to be in the “wrong” time zone?*

(ii) *Why is it not a problem that Singapore is in the “wrong” time zone?*

(iii) Judging from the map, you note that China spans four time zones. However, all of China uses the time zone of the capital, Beijing.

Is this a problem for people in the western part of China?

(iv) *If the capital of China had been in the western part of China, would it have been a problem for people in the eastern part of China to use the same time zone as the capital?*

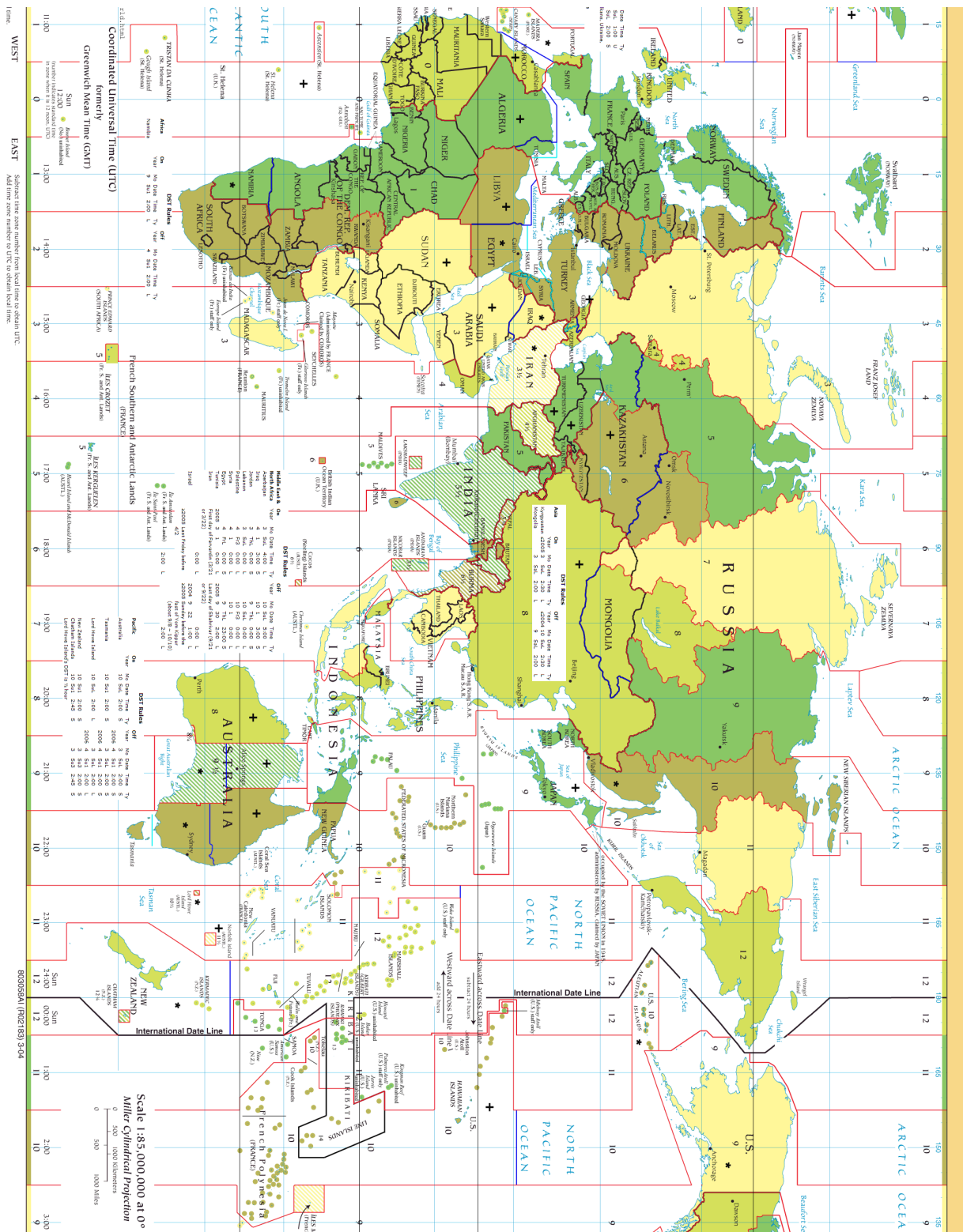


Figure 2: Time Zones

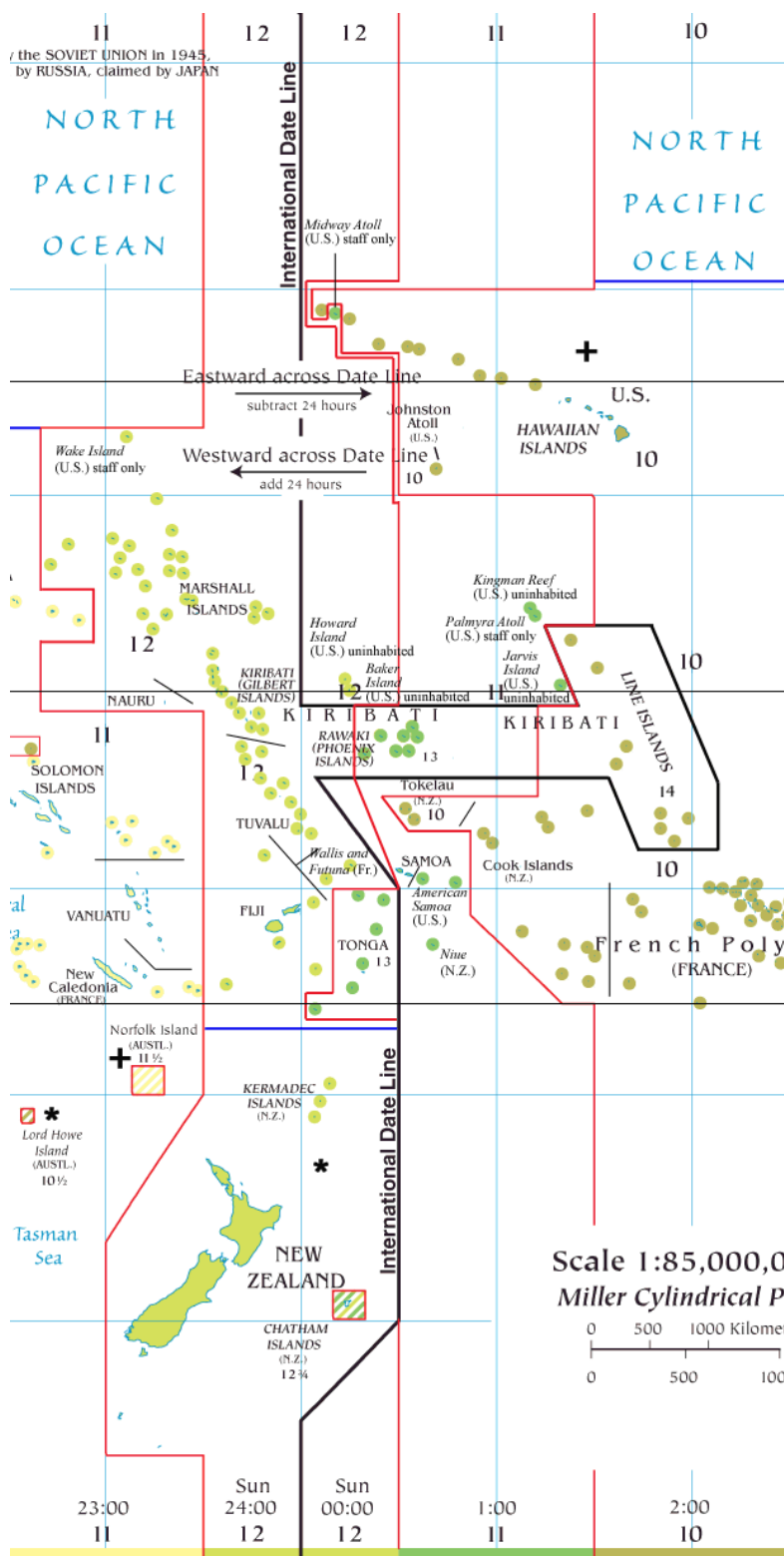


Figure 3: Time Zones

2. (i) Your friend notices that in the Pacific Ocean there are time zones called UTC(*GTM*)+12, UTC + 13, UTC + 14 and UTC – 12.

Why are these time zones confusing?

- (ii) At first you don't know how to explain this, but then you notice that the islands in UTC + 13 and UTC + 14 are parts of a country whose capital lies in UTC + 12 and most of the islands in UTC – 12 are part of the US.

How can you use this to explain the “extra” time zones?

3. Suppose you plan to leave Singapore at noon on 1 December 2006 and you travel 15° of longitude each day.
- (i) *If you travel eastward, when will you be back in Singapore?*
 - (ii) *If you travel westward, when will you be back in Singapore?*

4. When you suggest leaving on 1 December 2006, your friend becomes worried about making it back to Singapore for Chinese New Year. You know that in 2006, Chinese New Year was on 29 January.

When do you expect Chinese New Year to be in 2007?

5. You decide to travel eastward. Since you will leave in December, you want to first head to Wellington, New Zealand, at latitude 41° S to explore the southern summer and the southern sky.
- (i) *What is the right ascension of the December solstice?*
 - (ii) *Will you be able to see a star with right ascension 18h and declination -70° in Singapore in late December?*
 - (iii) *Will you be able to see a star with right ascension 18h and declination -70° in Wellington in late December?*

6. After a quick stop in Mexico studying Mayan pyramids, you fly on to visit a friend in Trondheim, Norway, who used to be an exchange student at the NUS. You would like to determine the geographical coordinates of Trondheim, so on the day of the December solstice on 22 December 2006 you observe the Sun crossing the meridian at 12:17 at an altitude of 3° in the south. Trondheim is in the UTC + 1 time zone, and the equation of time on 22 December is about 1 minute.

What is the latitude and longitude of Trondheim?

7. You're having a great time in Trondheim, and your friend invites you to stay until Easter. Unfortunately, your friend doesn't know when Easter will fall in 2007 and doesn't have an almanac for 2007. Fortunately, you manage to find an almanac for 2006, and you see that the spring equinox occurred at 18:26 UTC on Monday 20 March 2006. You also see that there was a full Moon at 16:40 UTC on Thursday 13 April 2006.
- (i) *What is the rule of thumb for computing the date of Easter?*
 - (ii) *Why is the rule difficult to implement unless you know a lot about mathematics and astronomy?*
 - (iii) *When do you think the spring equinox will occur in 2007?*
 - (iv) *When do you think the first full Moon after the spring equinox will be in 2007?*
 - (v) *When do you think Easter Sunday will be in 2007?*

8. Having sorted out Easter, you start looking at how the Muslim calendar is affected by the high latitude of Trondheim.
- (i) *What is the angle between the celestial equator and the horizon in Singapore?
What is the angle between the ecliptic and the horizon in Singapore?*
 - (ii) *What is the angle between the celestial equator and the horizon in Trondheim?
What is the angle between the ecliptic and the horizon in Trondheim?*
 - (iii) *How will the ecliptic lie with respect to the horizon in Trondheim at the time of sunset near the September equinox?*
 - (iv) *Why is this likely to delay the first visibility of the waxing crescent in Trondheim?*

END OF PAPER