**SPU 26 Assignment 6** Due Monday, November 12th before lecture

Your name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ TF’s Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Section time \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

On all parts please show your work for full credit.

**Part 1**

***Purpose***: To put together the material we’ve learned about the passage of the sun through the sky, and how to use this to find latitude and longitude. To a good approximation, the altitude of the sun in the sky, when plotted as a function of time, will resemble a parabola – that is to say, the curve of a quadratic polynomial.

You will measure several altitudes at different times of the day and enter them into the form on Week 9 of the course website. When ready, you’ll submit the data and the program will return to you the best fit to the time of the meridian passage of the sun and the best fit to the altitude of the sun at the meridian passage.

***Materials:***

1. A watch or clock: You’ll need a precise way of noting the time of your observations. Even if you have a watch or cell phone that automatically updates the time, please set it or check it against the time at the following website:

<http://www.time.gov>

 Remember to click on the east coast. We are now in Eastern Daylight Time (UTC-4), which is four hours behind Greenwich Mean Time. For most computers, this website is accurate to a few tenths of a second. NOTE: the ‘fall back’ date is Nov. 4th at 2:00 AM. If you take altitudes of the sun on or after Sunday, Nov. 4th, we will be on Eastern Standard Time (UTC-5), so make the appropriate adjustment.

1. A protractor with a straw and plumb-bob, like the one you used for both the observations of stars on the roof of the Science Center and the altitude of the meridian passage of the sun. The following tricks can help improve the accuracy of the readings: a) use a very thin string to make it easier to observe the tick marks, and b) consider putting the plumb bob in a bucket or jar of water to damp down the motion from the wind. (Also – please check the ‘zero’ of your protractor – when the plumb bob hangs down and make sure you’re really quoting the altitude – altitudes are never larger than 90o). The protractor should have a straw taped on the end as I showed in lecture (14). Remember to look at the image of the shadow of the sun and have the sun’s rays pass directly through the straw to align the protractor. **Do not look at the sun directly, as this can cause damage to your retina!**
2. A compass to observe the azimuth of the sun. You might want to pair up with a friend. For this. To find the azimuth of the sun, hold up your plumb-bob to the sun, and let it hang down. Note an object at approximately horizontal that coincides with the position of the plumb-bob and use your compass to sight on that. Remember to correct for magnetic declination.

***Instructions:***

1. **Measure the altitude and azimuth of the sun before, during, and after the meridian passage.** Try to pick a day where the weather forecast is clear. For best results on longitude, make sure you have a number of measurements relatively early in the morning (say, 9-10 AM) and in the afternoon (4-5 PM). For best results in latitude, make sure you have a number of measurements around 12:30 PM. Try to make all measurements in one day. If, however, clouds roll in, or it’s impossible to make measurements in one day, try to get a complete set in the morning, midday and in the afternoon and have them as close as possible together. One day’s separation is OK, but if you get off by multiple days, you’ll have problems, as the solar declination is changing fairly rapidly this time of year.
2. Plot the measurements of altitude versus time on graph paper. Remember that you’ll need to take into account 60 minutes = 1 hour – so 12:30 is 12.50 in ‘decimal hours’. Use a 24-hour notation: 13.00 is 1 PM, 14.00 is 2 PM etc. From this measurement make your best estimate of the altitude at meridian passage and your best estimate of the time of the meridian passage graphically by using the equal altitude method. You’ll probably need to draw a smooth curve through the points in the morning and the afternoon to refine your estimate. Please submit this graph and your estimates as part of the assignment. Plot the azimuth of the sun as a function of time and submit this. Can you estimate from the slope of the line, the change in azimuth per minute for the sun over the course of the day?*).* Report this.
3. Look up the declination of the sun and the equation of time on the NOAA website:

<http://www.srrb.noaa.gov/highlights/sunrise/azel.html>

Make sure you enter “Boston” as the city and click on “yes” for daylight savings time, if that is valid for the date of your measurements.

Report these values.

4.) Enter the data values into the Parabolic Fitter on the course

website on Week 9. It will return to you values for the time and altitude at

meridian passage.

5.) What is your estimate of your latitude and longitude from your graph? What is your estimate of your latitude and your longitude from the parabolic fit? Turn in the data points of altitude versus time, and azimuth versus time. What is the maximum altitude? What is the time of meridian passage? What is the solar declination you used? What value of the equation of time did you use? Show your work, please.

**Part 2**

***Purpose:*** To use the Mercator projection to compare dead reckoning to latitude and longitude.

Use the chart below to answer the following:

1.) The star on the chart represents the location of the town of Chatham, Massachusetts. The magnetic declination is 16o W of true north. You start sailing from Chatham on a *magnetic* heading of 79o for 22 hours as a speed of 6 knots and stop. Plot your course and final position on the chart and turn it in with your assignment. What is the latitude and longitude of your position? If the date is November 1, 2012, what do you expect as the time of the meridian passage of the sun in EDT? What do you expect to see for the altitude of the sun at its meridian passage?

2.) Again, assume you are starting in Chatham. You wish to sail to a position in the George’s Bank that is 41o 40’ N latitude and 67o 35’ W longitude. What *magnetic* heading should you take, assuming you take a straight-line course? If you sail at a speed of 6 knots, how long do you expect it will take to reach that location?

**Assignment 6**

**Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_ TF\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date of measurements\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Please attach graph of altitude versus time, azimuth versus time.

**Maximum altitude\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Time of meridian passage\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Solar declination for date of measurement\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Equation of time for date of measurement\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Latitude from measurements\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Longitude from measurements\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

