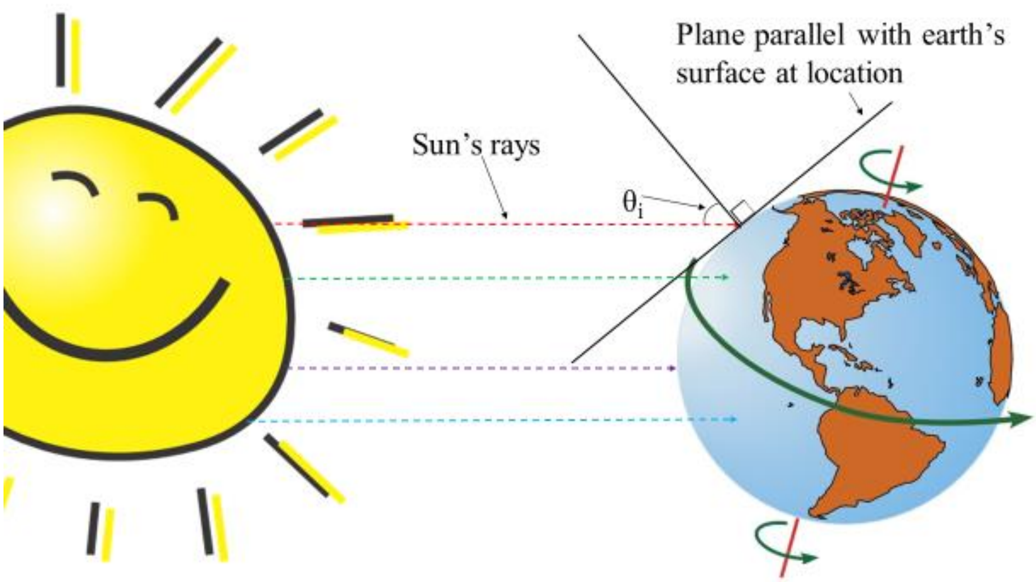
Recitation Assignment #7

Please do the following problems during your recitation session, including any additional problems given to you by your TA. Within 72hrs of your recitation session, you must upload the complete solutions to these problems to Sakai, so that your TAs can evaluate them in a timely fashion. **Please submit any .m files to Sakai. Your .m files should be named in the following format: NETIDRecitation7Problem#, where NETID is your NetID, and # is the problem number. For instance if your NetID was aaa111, and you were answering problem 3, your .m file would be named aaa111Recitation7Problem3.m. All of your .m files should be in the form of a function. If you do not meet these naming requirements, and do not save as a function, you will not receive credit for your submission.** Collaborative problems can be worked on in teams of up to 5 people, as long as each team member individually completes the problem uploads the solution as part of their own Sakai submission or shows the solution to their instructor individually, and lists the names of all collaborators in the Sakai submission. Collaboration and discussion of solutions is not permitted for questions labeled as individual problems.

1. [Collaboration] Create a function that calculates the incident angle of the sun's rays at solar noon (the highest point of the sun in the sky) given a certain latitude and a certain day of the year.



The incident angle depends on two things. The first is the declination angle, which is the angle of incidence of the sun at the equator. For a given day, the equation for declination angle is:

$$\delta = 23.45 \sin\left(2\pi \frac{284 + day}{362.5}\right)$$

Where the *day* is an integer from 1 to 365, where 1 is January 1st and 365 is December 31st. Note that the argument of the sine function is in *radians*, but the declination angle (δ) we get is in *degrees*.

Once we know the declination angle, the magnitude of the incident angle (θ_i) is given as:

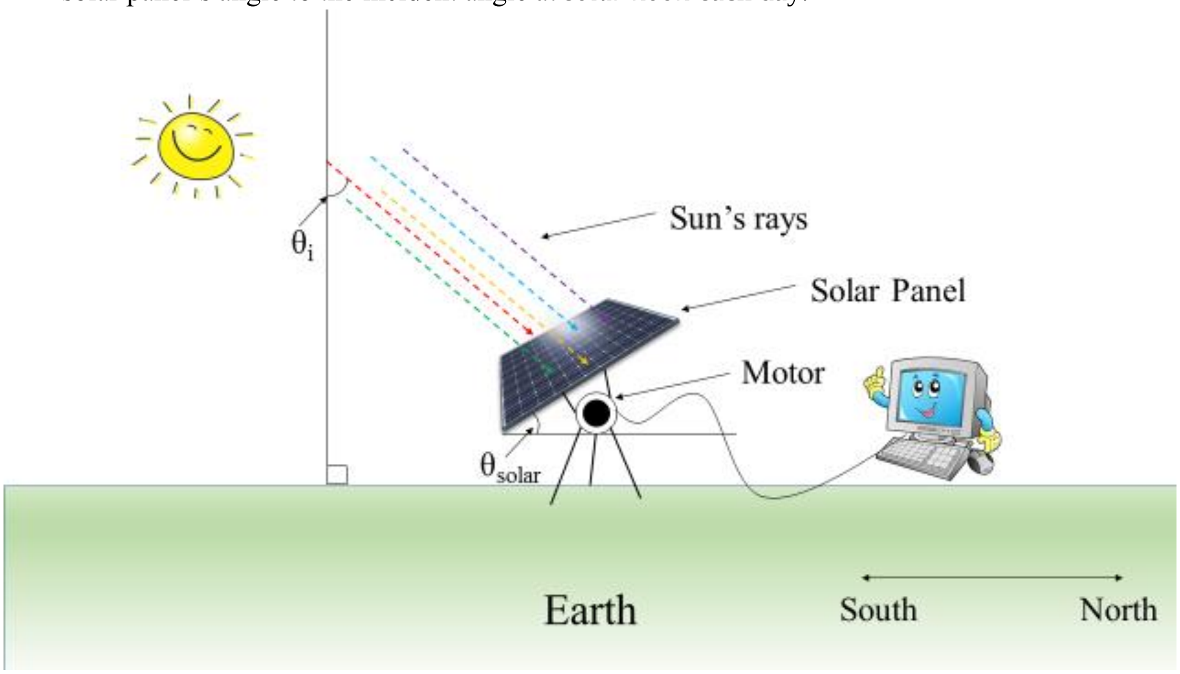
$$\cos\theta_i = \cos\delta \cos latitude + \sin\delta \sin latitude$$

Where δ and *latitude* are in degrees. Note that θ_i is *negative* when *latitude* – $\delta > 0$ and *positive* otherwise. An angle of 0 means that the sun's rays are perpendicular to the ground. A negative angle means the rays are angled towards the north, and a positive value means that the sun's rays are angled towards the south. A magnitude of more than 90 degrees means that that latitude receives no sunlight on that day!

Remember: 1st input is latitude, 2nd input is day

Useful hints: There are different commands for sinusoid functions depending on whether the input is in radians (sin) or degrees (sind). Be careful to use the correct ones for this program.

2. [Collaborative] Imagine you have a solar panel. To get the most out of a solar panel on a given day, you need to know what the incident angle of the sun's rays will be, and adjust the angle of your solar panel to that angle. We have simplified this problem so that we are only matching the solar panel's angle to the incident angle at *solar noon* each day.



Assume we have a solar panel on a platform attached to a motor. We need to write a function that can adjust the motor in *very fine* increments of 0.01 degrees so the motor runs slowly and uses a minimal amount of energy. **Note that you are writing a function that adjusts your motor only once.** Ideally, $\theta_{solar} = \theta_i$ as shown in the diagram above. Your function should take in an incident angle and a solar panel angle, and return a solar panel angle that is *exactly* 0.01 degrees closer to the incident angle as it was originally. If you are within 0.01 degrees of the incident angle, do nothing. Remember that incident angles (and solar panel angles) can be negative (tilted towards the south) or positive (tilted towards the north). If the incident angle means that there will be no sunlight (magnitude is greater than 90), move the solar panel's angle closer to 0, instead of towards the incident angle.
1st input is incident angle
2nd input is solar angle

3. [Collaborative] You have a solar power supply attached to a portable weather station, and you want to use your other two functions to adjust your solar panel's angle for maximum efficiency. When the weather station is moved, the angle is set back to 0, so every day, the panel must be readjusted from 0. Write a function that takes in a latitude and a day, and adjusts the angle of the solar panel to match the incident angle of the sun. **Use your functions from the previous two problems to do this**.

   1st input is latitude

   2nd input is day

   Extra: Do NOT turn in your functions with any modifications made from this extra part. Add a 0.25 second pause after each motor adjustment, and display the current angle of the motor in the command line. This is to simulate the motor slowly adjusting to the correct angle. You will want to use the built in MATLAB functions "pause" and "display" to do this. Again, DO NOT hand in your function for this problem with pause or display. Those things make our auto-grader very, very sad. **End extra.**

4. [Collaborative] Download the file rec7prob4WRONG.m . Read the comments carefully to figure out what the program is supposed to do. Then follow debugging procedures to fix the program. Don't forget to change the name before you submit!