PLEASE READ THIS PAGE FIRST

A statement on collaboration is required for all reports, including those that are done independently without any collaboration. See instruction below on how to prepare the statement. Please read the rules before forming any collaboration for the homework. A violation of the rule(s) given in this page will be considered a violation of ASU's Academic Integrity Policy.

Rules on collaboration for homework:

(1) Collaboration is not allowed unless all involved follow rules (2)-(3) and unless the extent of collaboration is properly disclosed in a statement in the first page of the report for the assignment. See additional instruction below for the required content of the statement.

(2) For each assignment, each person can have maximum of one collaborator. Be aware that a collaborator's collaborator counts as a collaborator. For example, if Alice collaborates with Bob and Bob collaborates with Charles, Charles counts as a collaborator of Alice. All three violate the rule. In other words, collaboration can only be carried out within an isolated "team of two". Please talk to a potential collaborator to ensure that this rule is not violated before establishing any collaboration.

(3) In a legitimate collaboration, each individual must make a non-negligible contribution to the collaborative effort. Taking the solution or code from another student without making a reciprocal contribution to it is not allowed. To certify that a collaboration is legitimate, the submitter's contribution to the collaborative effort must be documented in the statement on collaboration.

The statement on collaboration

This statement is mandatory and must be placed in the beginning of the first page of report. If no collaboration occurred, simply state "**No collaboration**". This implies that the person submitting the report ***has not helped anyone or received help from anyone*** in the process of completing the assignment. If collaboration occurred, provide the name of collaborator (only one allowed), a list of the task(s) on which collaboration occurred, and descriptions of the contribution by the submitter to the collaborative effort. Example:

Name of collaborator: Joe Smith	
Task(s), specific detail	Contribution to collaborative effort
Prob 1, matlab code	Developed codes with collaborator
Prob 3, mathematical derivation	Helped check mathematical equations

MAE 578, Spring 2019 Homework #1

One homework set ≈ 10% of the total score for the semester. We expect to have six homework assignments. Hard copy of report is due at 4:35 PM on the due date. Please follow the rules on collaboration as described in the cover page of this document. **A statement on collaboration is required for all reports, including those that are done independently.**

Prob 1. (40%)

Consider a three-layer model of the atmosphere as illustrated in Fig. 1. All three layers have an infrared absorptivity (and emissivity) of ε. All layers, except the top one (marked by "T_3") in case (iv) below, are completely transparent to solar radiation. The absorptivity of solar radiation for the top layer is β. A non-zero value of β emulates the absorption of solar radiation by ozone in the stratosphere. The surface albedo for solar radiation is $\alpha = 0.1$ for all cases. The effective solar input from the top of the atmosphere is $S_0/4$, where $S_0 = 1368$ W m^{-2} is the solar constant. If needed in the calculations, Stefan-Boltzmann constant is $\sigma = 5.67 \times 10^{-8}$ W m^{-2} °K^{-4}. Based on radiative energy balance, calculate and plot the temperature profile, (T_s, T_1, T_2, T_3), for the following four cases: (i) $\varepsilon = 0.1$, $\beta = 0$, (ii) $\varepsilon = 0.5$, $\beta = 0$, (iii) $\varepsilon = 0.9$, $\beta = 0$, (iv) $\varepsilon = 0.5$, $\beta = 0.4$. Please collect all four curves in a single plot and label the curves clearly. In addition, provide the numerical values of the surface temperature for the four cases.

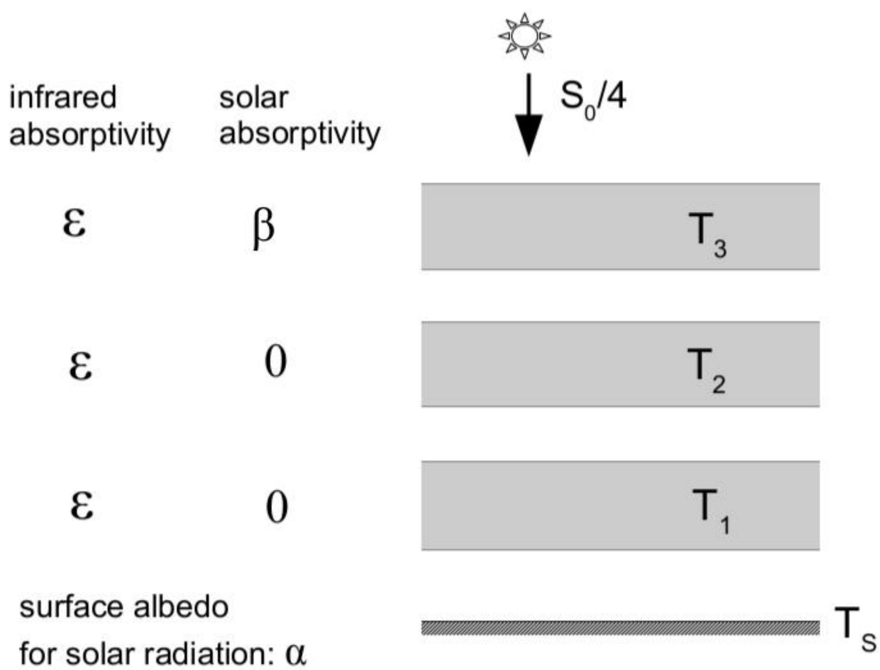

Fig. 1

Prob 2 (20%)

Solve Problem 5, Part (a) and (b), in Chapter 2 of the textbook. In addition, complete the extra task:
(c) Consider a 10-layer atmosphere, i.e., N = 10. Determine the temperature of the surface and 10 atmospheric layers and make a plot of the temperature profile using T_s and (T_1, T_2, …, T_{10}) (total of 11 data points).

Prob 3 (40%)
An idealized temperature profile for the atmosphere is given as

$$T(z) = \begin{cases} T_1(z)\,, & if\ 0 \le z \le 12\ km \\ T_2(z)\,, & if\ 12\ km < z \le 25\ km \end{cases}$$

where

$T_1(z) = T(0) + \alpha\, z$, $T(0) = 300$ °K, $\alpha = -8$ °K/km

$T_2(z) = T_1(12\ km) + \beta(z - 12\ km)$, $\beta = 4$ °K/km .

The whole profile of $T(z)$ is shown in Fig. 2. Note that α is negative. One could nominally consider the portion of the atmosphere described by $T_1(z)$ as the "troposphere", and that described by $T_2(z)$ as the "stratosphere". The atmosphere is an ideal gas in hydrostatic equilibrium. The surface pressure is given as p(0) = 1000 mb (1 mb = 100 Pascal). Gravity is $g = 9.81$ m s^{-2} and the gas constant for ideal gas is $R = 287$ J kg^{-1} °K^{-1}.
(a) Calculate pressure and density as a function of height, $p(z)$, and $\rho(z)$, and make plots of the two profiles over the range of $0 \le z \le 25$ km. In addition, provide the numerical values of p and ρ at z = 12 km and z = 25 km.
(b) Calculate the thickness (in meters) of the atmosphere between the 800 mb and 300 mb levels.

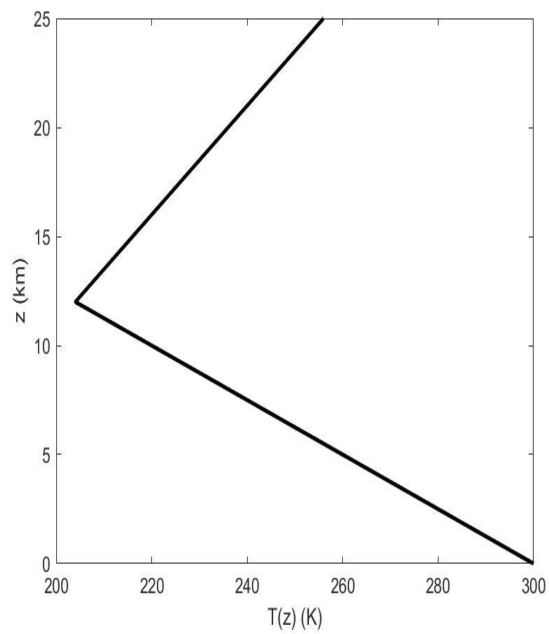

Fig. 2