

CEE 3804 Exam1 (Spring 2022)

Computer Applications in Civil Engineering

Open Book and Notes

Your Name _____

Your Signature * _____

* The answers in this exam are the product of my own work. I certify that I have not received nor I have provided help to others while taking this examination.

Directions:

Solve the problems. Copy and paste the VBA code and solutions such as graphs in a Word Document and convert to a single PDF file. **Make sure your code is not too small for me to be able to read it.** Minimum font size 10 is acceptable.

Problem 1 (30 points)

A common model used in engineering and meteorology to estimate the temperature (T) in the standard atmosphere is shown below. The units in this model are all

$$T = \begin{cases} T_0 + \lambda(h - h_0) & \text{if } h \leq 11,000 \text{ m} \\ 216.5 \text{ deg. K} & \text{if } h > 11,000 \text{ m} \end{cases}$$

where:

T = air temperature at altitude h (deg. Kelvin)

T_0 = air temperature at sea level (deg. Kelvin)

λ = is the temperature lapse rate (i.e., change) with altitude (deg. Kelvin per meter)

h = is the altitude (in meters) at which we want to know the atmospheric variables

h_0 = is the value of the sea level reference altitude (meters)

consistent.

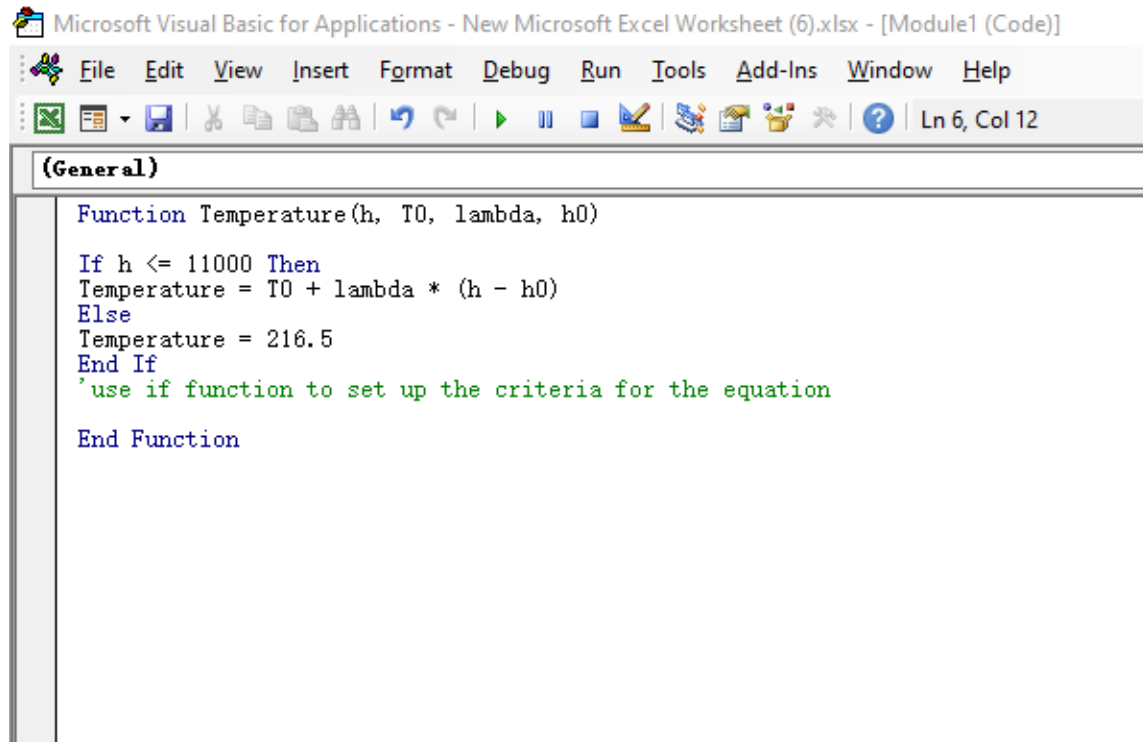
The numerical values of sea level conditions are given in the table below:

Table 1. Numerical Constants of the Standard Atmospheric Model.

Constant	Value
T_0	288 deg. Kelvin
λ	- 0.0065 Kelvin/meter (negative slope)
h_0	Mean sea level condition (0 meters)

a) **Create a VBA function (not a Sub)** that estimates the value of temperature (T) for a given value of altitude (h) in meters. In this analysis assume the mean value of the reference altitude (h_0) is zero.

Answer



The screenshot shows the Microsoft Visual Basic for Applications editor window. The title bar reads "Microsoft Visual Basic for Applications - New Microsoft Excel Worksheet (6).xlsx - [Module1 (Code)]". The menu bar includes File, Edit, View, Insert, Format, Debug, Run, Tools, Add-Ins, Window, and Help. The toolbar contains various icons for editing and execution. The status bar at the bottom indicates "Ln 6, Col 12". The code editor window is titled "(General)" and contains the following VBA code:

```
Function Temperature(h, T0, lambda, h0)
    If h <= 11000 Then
        Temperature = T0 + lambda * (h - h0)
    Else
        Temperature = 216.5
    End If
    'use if function to set up the criteria for the equation
End Function
```

b) Create a table of altitude values in Excel (say in column A) ranging from 0 to 13,000 meters at steps of 1,000 meters. Use the function created in part (a) to estimate the temperature (T). Provide headers with labels and units in your table. You can write the headers directly in Excel to save time.

Include screen captures of VBA function code and also a screen capture of the table with solutions obtained for (T). Show me a sample of how do you invoke (use) the function in Excel (a screen capture of the **formula bar is acceptable).**

Answer:

The screenshot shows the Microsoft Excel Developer tab. The formula bar contains the function: `=Temperature(A12,B6,B7,B8)`. The spreadsheet contains the following data:

	A	B	C	D	E	F
1	Function					
2	If $h \leq 11,000$ m	$T = T_0 + \lambda(h - h_0)$				
3	If $h > 11,000$ m	$T = 216.5$ deg.K				
4						
5	Constants					
6	T0	288	deg.K			
7	λ	-0.0065	kelvin/meter			
8	h0	0	meter			
9						
10	Altitude(m)	Temperature(deg.K)				
11	h	T				
12	0	288				
13	1000	281.5				
14	2000	275				
15	3000	268.5				
16	4000	262				
17	5000	255.5				
18	6000	249				
19	7000	242.5				
20	8000	236				
21	9000	229.5				
22	10000	223				
23	11000	216.5				
24	12000	216.5				
25	13000	216.5				
26						
27						
28						

Problem 2 (40 points)

The following linear programming problem has been developed to predict resource

$$\text{Max } Z = 340x_1 + 150x_2$$

subject to:

$$x_1 \leq 100$$

$$230x_1 + 150x_2 \leq 44000$$

$$10x_1 + 20x_2 \leq 5000$$

$$x_1 \text{ and } x_2 \geq 0$$

allocation at a company.

a) Convert the problem shown above into standard (**canonical**) form to be solved by hand using the Simplex Method. Write down the transformed equations and add slack variables as needed.

Answer:

$$230x_1 + 150x_2 + x_3 = 44000$$

$$10x_1 + 20x_2 + x_4 = 5000$$

$$x_1 + x_5 = 100$$

$$x_1, x_2 \geq 0$$

b) Show me the first **two tables of the hand calculations using the Simplex Method**. Indicate the values of all decision variables in every table. Indicate the value of the objective function Z in every table. This task requires hand calculations and you need to show me your row operations clearly.

Show me the problem in standard form and then two tables to solve the problem.

Answer:

First Table							
BV	Z	x1	x2	x3	x4	x5	RHS
Z	1	-340	-150	0	0	0	0
x3	0	230	150	1	0	0	44000
x4	0	10	20	0	1	0	5000
x5	0	1	0	0	0	1	100

Calculation 1							
BV	Z	x1	x2	x3	x4	x5	RHS
Z	1	0	-150	0	0	340	34000

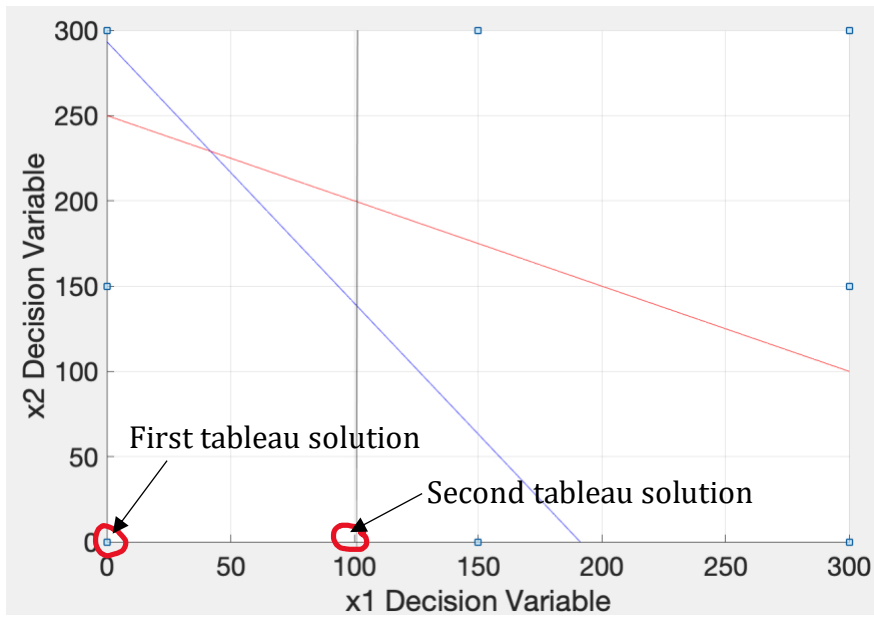
Calculation 2							
x3	0	0	150	1	0	-230	21000
x3	0	0	150	1	0	-230	21000

Calculation 3							
x4	0	0	20	0	1	-10	4000
x4	0	0	20	0	1	-10	4000

Second Table							
BV	Z	x1	x2	x3	x4	x5	RHS
Z	1	0	-150	0	0	340	34000
x3	0	0	150	1	0	-230	21000
x4	0	0	20	0	1	-10	4000
x1	0	1	0	0	0	1	100

Solution in Table 1 is: $x = 0, x_2 = 0, x_3 = 44000, x_4 = 5000, x_5 = 100. Z = 0.$

Solution in Table 2 is: $x = 100, x_2 = 0, x_3 = 21000, x_4 = 4000, x_5 = 0. Z = 34,000.$



Graphical solution (not needed).

Problem 3 (30 points)

Short answers:

- a) An engineer develops a program to estimate the deflections of a 12-meter beam subject to a uniform load. The engineer saves the deflection and stress estimates every 10 centimeters. Find the number of bytes in the computer memory needed to store all deflections and stresses along the beam if every deflection and stress is to be saved in double precision.

Answer: 1920 bytes

8 bytes per value (2 values needed for each station of the beam). 120 stations along the beam. 240 total values saved. 1920 bytes.

- b) Use the file named **Construction_firm** available on Week 2 of the Syllabus website to create a Pivot Table that counts the number of construction equipment assets (i.e., truck, scraper, etc.) **in-maintenance** by location. Highlight the number of trucks in-maintenance at the New York site.

Answer:

Status	In-maintenance <input type="checkbox"/>			
Count of Value (\$)	Location <input type="checkbox"/>			
Equipment <input type="checkbox"/>	Atlanta	Charlotte	New York	Grand Total
Loader	10	13	11	34
Scraper	4	5	12	21
Truck	9	20	23	52
Grand Total	23	38	46	107

There are totally 107 construction equipment assets in-maintenance. There are 23 trucks in-maintenance in the New York location.

Show me your Pivot table and indicate the answer for part (b).