CEE 3804 Exam1 (Spring 2026)

Computer Applications in Civil Engineering

Take Home Exam: Open Book and Notes

Due March 20, 2026

Your Name _____

Your Signature * _____

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

Directions:

Solve the problems. Copy and paste the VBA code and solutions, such as graphs, into a Word Document and convert to a single PDF file. **Make sure your code is not too small for me to read.** Minimum font size 12 is acceptable.

Problem 1 (50 points)

A common problem in Civil Engineering is to estimate the deflection of beams used in building construction projects.
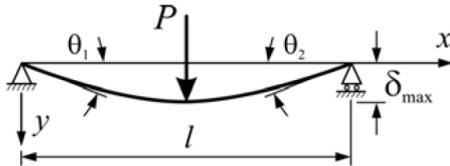

Figure 1. Beam deflection diagram when the load is applied at the middle point of the beam (**Source: https://home.engineering.iastate.edu/~shermanp/STAT447/STAT Articles/Beam_Deflection_Formulae.pdf**)

The deflection of the beam at any station x measured from the left-hand side support (see Figure 1) is presented below. Note that the deflection formula below applies to values from the left support to the middle point of the beam where the load is applied. The deflections for values of x greater than $l/2$ are symmetrical to those estimated with the deflection formula below.

$$y = \frac{Px}{12EI}\left(\frac{3l^2}{4} - x^2\right) \quad \text{for } 0 < x < \frac{l}{2}$$

Where:

y is the beam deflection in meters

P is the applied load at the center point of the beam (Newtons)

l is the length of the beam in meters

x is the station measured from the left beam support (meters)

I is the beam moment of inertia (m⁴)

E is the modulus of elasticity (N/m²). Note 1 N/m² = Pascal

The maximum deflection of the beam is:

$$y_{max} = \frac{Pl^3}{48EI}$$

Table 1. Typical Values of E for Various Materials

Material	E Value (N/m²)
Steel	2E+11
Tungsten	4.1E+11
Cast Iron	8.5E+10
Magnesium	4.5E+10
Brass	1.06E+11
Copper	1.2E+11
Aluminium	7.1E+10

a) **Create a VBA Subroutine** to estimate the value of the beam deflection (y) at any point (x) along the beam as a function of the parameters in the equation above. The user provides the values of P, l, I, x, in the Excel interface. The value of E is entered by the user in Excel using a data validation list containing the names of the materials listed in Table 1. The VBA code assigns the corresponding value of E based on the selected material.

b) Test the code using the following numerical values:

P = 12,000 (Newtons)

l = 5 meters

x = 2.5 meters

I = 0.0004 (m⁴)

Material = steel

Display the answer for y in the Excel interface.

c) Add VBA code to estimate the maximum deflection y_{max}. Write the solution of the maximum deflection to the Excel interface. Label appropriately.

d) Create more VBA code to produce a table with multiple values of deflection y for values of x (i.e., beam station) ranging from 0 to $l/2$. Select an appropriate step size to produce a table with a minimum of 50 points along the beam from 0 to $l/2$. Test the code using the following numerical values:

P = 15,000 (Newtons)

l = 5 meters

I = 0.0004 (m⁴)

Material = aluminium

e) Plot the values generated in the table (part d) and label appropriately.

Show me all your code in screen captures. Unreadable font size will not be accepted. Please make sure the equivalent font size of the screen capture is at least 12.

Problem 2 (30 points)

A file containing access to drinking water is shown below. The file is provided on the assignments website. Use the file to answer the following questions.

Entity	Code	Year	Usage of safely managed drinking water services (%)
Afghanistan	AFG	2000	11.48
Afghanistan	AFG	2001	11.50
Afghanistan	AFG	2002	12.30
Afghanistan	AFG	2003	13.10
Afghanistan	AFG	2004	13.91

Figure 2. World Sanitation and Drinking Water Access. https://ourworldindata.org/clean-water-sanitation

The fields in the file are explained below.

Entity - country or region of the world

Code - country or region code

Year - year of the data collected

Usage of safely managed drinking water - Percent of the population with access to clean drinking water (%)

a) Create a Pivot Table to summarize the average of managed drinking water services by entity. Use the year field as a filter in the pivot table.

b) For the solution of the pivot table in part (a), do conditional formatting on the average of managed drinking water services by entity. Use the following scales:

   a. Red - lower or equal than 30%

   b. Light blue - > 30% and <= 60%

   c. Yellow - > 60% and <= 80%

   d. Green - >80%

   Show me a screenshot of the first 15 entities, and the average of managed drinking water services by entity for t023.

c) Create a pivot chart showing the average managed drinking water services by entity for 2020. Show me a screen capture of the pivot chart (the first 20 entities).

d) Find the country with the highest average number of managed drinking water services in 2023.

Show me the Pivot Table, Pivot Chart, etc. Highlight the numbers with your answers.

Problem 3 (20 points)

Provide quick answers or True or False.

Question	Answer
Can a number like 230 million be stored in a **variant** data type in VBA?	
Can a subroutine take two inputs and produce three outputs?	
Moore's Law states that the number of transistors on a computer microprocessor doubles approximately every 2 years.	
Type of VBA data structure (i.e., variable type) that can hold integer values up to 1.2 million.	
A civil engineering collecting pavement deflection data collects the following items: 1) a highway marker serial number (single precision), 2) the deflection at each point (double precision), and 3) the stress value at each point (double precision). If the number of data collection includes 35,000 highway marker serial numbers over a week, estimate the number of bytes of computer memory required to hold all the calculations in memory.	
R is a specialized language for statistical analysis and computations.	
A VBA function can produce two outputs.	
Keyword required in VBA to declare all variables inside a subroutine.	
Evelyn Berezin designed a computer reservation system for Delta Airlines.	