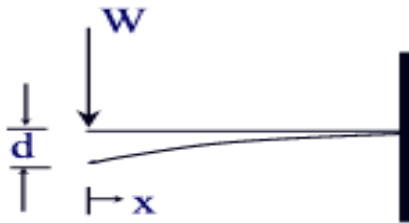


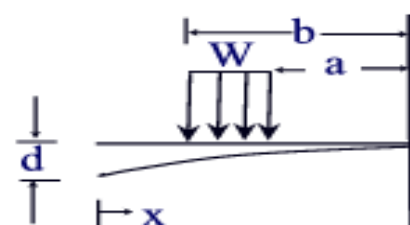
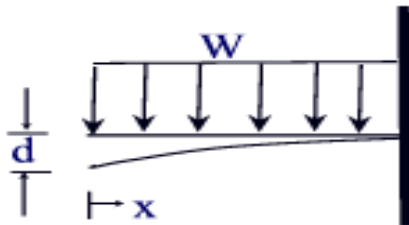
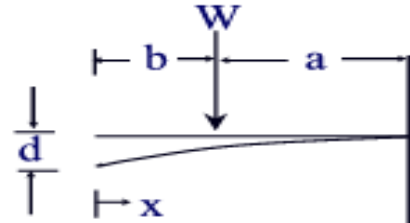
Engr 160 Homework Assignment
Due: Nov 7

A cantilevered beam has one end clamped in place and the other end free. For example, an aircraft wing can be considered to be a cantilevered beam. The deflection (from horizontal) of the free end of the beam depends upon the loading conditions on the beam. Four of the many loading conditions are shown below.

Case 1: End Load, W



Case 2: Intermediate Load, W



Case 3: Uniform Load, $W = \text{unit_w} * L$

Case 4: Partial Uniform Load, $W = \text{unit_w} * (b-a)$

W = total load, N

unit_w = unit load in uniform (or partial uniform) case, N/m

d = deflection caused by the load, m

x = distance from the free end of the beam, m

L = length of the beam, m

By assuming that all forces are coplanar, the beam is in static equilibrium, and the mass of the beam can be neglected, the following equations can be used to calculate the deflections for the four load cases.

Case 1:
$$d = \left(\frac{-W}{6EI} \right) (x^3 - 3L^2x + 2L^3) \quad \text{for } 0 \leq x \leq L$$

Case 2:
$$d = \left(\frac{-W}{6EI} \right) (-a^3 + 3a^2L - 3a^2x) \quad \text{for } 0 \leq x < b$$

$$d = \left(\frac{-W}{6EI} \right) ((x-b)^3 - 3a^2(x-b) + 2a^3) \quad \text{for } b \leq x \leq L$$

Case 3:
$$d = \left(\frac{-W}{24EIL} \right) (x^4 - 4L^3x + 3L^4) \quad \text{for } 0 \leq x \leq L$$

Case 4:

$$d = \left(\frac{-W}{24EI} \right) \left[4(a^2 + ab + b^2)(L-x) - a^3 - ab^2 - a^2b - b^3 \right] \quad \text{for } 0 \leq x < (L-b)$$

$$d = \left(\frac{-W}{24EI} \right) \left[6(a+b)(L-x)^2 - 4(L-x)^3 + \left(\frac{(L-x-a)^4}{b-a} \right) \right] \quad \text{for } (L-b) \leq x < (L-a)$$

$$d = \left(\frac{-W}{12EI} \right) \left[3(a+b)(L-x)^2 - 2(L-x)^3 \right] \quad \text{for } (L-a) \leq x \leq L$$

E = modulus of elasticity, Pa

I = moment of inertia, m⁴

The modulus of elasticity, E is dependent on the type of material of which the beam is made and the moment of inertia, I is dependent on the cross-section of the beam.

Program Requirements:

1. Write a **Main** program and two user-defined **Subroutine** subprograms.
2. In the **Main** program, prompt the user to enter the number of cases that will be considered.
3. In the **Main** program, read from the given file (**BeamCase.txt**): the I and E values, the case number and the values of the necessary variables to analyze that case (W, UnitW, a and b)
4. In one **Subroutine**, calculate the **deflection, d** of the beam at **10 equally spaced locations along the beam** (include the free end, but not the clamped end).
5. In this Subroutine, the deflections and corresponding x values (distance from free end) must be stored in **two different one-dimensional arrays**.
6. Return the calculated d, deflection and x, distance arrays to the main program.
7. Use a second **Subroutine** to output to a file (**BeamCase_LastnameFirstName.txt**) a formatted table showing the values that were entered for each case and the 10 deflections as a function of x. Be sure all values have units labeled.

Presentation Requirements:

1. Create a **Word** document as the **complete** solution.
2. Include a **complete write-up** (Problem Statement, Assumptions, Theory, Solution, and Discussion).
3. In the **Solution** section include: flowcharts (**three flowcharts** will be needed, one for the main program and one for each subprogram), copy of the computer code, a copy of the input file, a copy of the output file and a Command Button to use to run the program.
4. Flowcharts and computer code should be well commented.
5. Include an **Excel graph** of d versus x for all four given loading situations on one set of axes.
6. Be sure to discuss your results including comparison of the different types of loading conditions.

You need to have your program read from the given file shown below: BeamCase.txt

 BeamCase.txt - Notepad

File Edit Format View Help

```
4.15E-8, 2.05E11
4
2.0, 250.0, 0.25, 0.75
2
2.0, 150.0, 0.5
3
2.0, 150.0
1
2.0, 150.0
```

This file contains the values for five loading situations to analyze in the following order:

- Line 1: I, E
- Line 2: Case #
- Line 3: L, UnitW, a, and b
- Line 4: Case #
- Line 5: L, W, a
- Line 6: Case #
- Line 7: L, UnitW
- Line 8: Case #
- Line 9: L, W

Results for Case Number 1 , End Load.
The moment of inertia = $4.15\text{E-}08 \text{ m}^4$.
The modulus of elasticity = $2.05\text{E+}11 \text{ Pa}$. The beam length = 2 m
The load = 150.0 N, and it is located at the free end of the beam.

Distance from free end, m	Beam Deflection, m
0.0	-4.70E-02
0.2	-4.00E-02
0.4	-3.31E-02

```
Results for Case Number 2 , Intermediate Load.
The moment of inertia = 4.15E-08 m^4.
The modulus of elasticity = 2.05E+11 Pa. The beam length = 2 m
The intermediate load = 150.0 N, and it is located 0.5 m from the fixed end of the beam.

Distance from free end, m      Beam Deflection, m
0.0                             -4.04E-03
0.2                             -3.60E-03

.....

1.6                             -5.17E-04
1.8                             -1.53E-04
```

The results for case number 3
The moment of inertia for this beam is $4.15\text{E-}08 \text{ m}^4$
The Modulus of elasticity for this beam is $2.05\text{E}+11 \text{ Pa}$
The beam length is 2 m
The load is 300 N , located at free end of the beam.

The distance from the beam's free end, m.	Deflection created due to the load, m
0	-0.035263
0.2	-3.056244E-02

Results for Case Number 4 , Partial Uniform Load.
The moment of inertia = 4.15E-08 m⁴.
The modulus of elasticity = 2.05E+11 Pa. The beam length = 2 m
The partial unit load = 250.0 N/m,
and it begins 0.25 m from the fixed end of the beam and ends 0.75 m from the fixed end of the beam

Distance from free end, m	Beam Deflection, m
0.0	-3.60E-03
0.2	-3.20E-03