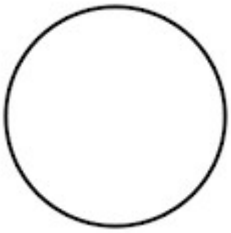

INTERMEDIATE STRENGTH OF MATERIALS

FALL 2021

Communication Project 1:

"Application of the Direct Integration Method or of Discontinuity (Singularity) Functions to Statically Determinate Uniform or Stepped Beam Design"

Requirements and Deliverables

(assigned: Friday, September 10, 2021; submission date: Friday, October 1, 2021; not later than 4:00 pm)

"You will be judged in industry not on [only] your work but how well you communicate your work," **Charles R. Cluer "A Survey of Industrial Mathematics", page 277, Dover, 2012. The requirements that should be satisfied by the project are given in the document called FORMAT (see CANVAS).**

Problem 1

For the beam that is depicted below is subjected to a distributed load w_0, concentrated load P and concentrated moment M_0. The length is specified L= 2 meters. The cross section is represented by an I-beam. Material is aluminum; yield stress= 276 MPa; E= 69.9 GPa; required safety factor is k= 1.5. The allowable displacement $v_{allow=}$ $L/500$. Design the beam so that it satisfied strength condition, as well as stiffness condition. The moments of inertia of I-beams are given on pages 804-805 of the textbook, the number ***s*** is your serial number. Note: don't forget to depict FBD. Write equations to determine reactions. Use singularity functions, not the superposition principle. Please do not use SKYCIV software.

Problem 2

For the beam that is depicted is subjected to a distributed load w_0, concentrated load P and concentrated moment M_0. The length is specified L= 2 m. The cross section is circular with radius c. Material is aluminum; yield stress= 276 MPa; E= 69.9 GPa; required safety factor is k= 1.5. The allowable displacement $v_{allow=}$ $L/400$. The number s is your serial number. Use singularity functions, not the superposition principle. Please do not use SKYCIV software.

(a) Design the beam—find minimum allowable radius of cross section-- so that it satisfies strength condition, as well as stiffness condition.
(b) Write resulting expression of $V_y(x)$ and $M_z(x)$.
(c) Construct diagrams of the shear force $V_y(x)$ and bending moment $M_z(x)$ as well as for deflection $v(x)$. Note: don't forget to depict FBD. Write equations to determine reactions

Problem 3

The beam is subjected to concentrated loads as shown in the figure. The number of loads equals 100-*s*, where *s* is your serial number. Find the maximum displacement of the beam. Note: don't forget to depict FBD. Write equations to determine reactions. Use singularity functions, not the superposition principle. Please do not use SKYCIV software.

Problem 4

For the beam that is depicted is subjected to a distributed load w_0, concentrated load *P* and concentrated moment M_0. The length is specified *L*= 2 m. The cross section is represented by a rectangle who base is three times less than its height (or depth). Material is aluminum; yield stress= 276 MPa; *E*= 69.9 GPa; required safety factor is *k*= 2. The allowable displacement $v_{allow=}$ *L*/400. The number *s* is your serial number. Use singularity functions, not the superposition principle. Please do not use SKYCIV software.

(d) Design the beam so that it satisfied strength condition, as well as stiffness condition, i. e. find minimum allowable value of the beam's hight (depth).

(e) Write resulting expression of $V_y(x)$ and $M_z(x)$.

(f) Construct diagrams of the shear force $V_y(x)$ and bending moment $M_z(x)$ as well as for deflection $v(x)$. Note: don't forget to depict FBD. Write equations to determine reactions

Problems 5-6

Determine the maximum deflection in the beam subjected to following loading. The cross-section is given by American Standard Channel (p. 810). Make a choice of the material, as well as (nonzero) values of w_0 and M_0. Determine the maximum deflection. Does it occur in the middle cross-section? Note: don't forget to depict FBD. Write equations to determine reactions. Use singularity functions, not the superposition principle. Please do not use SKYCIV software.

Problems 7

For the beam that is depicted below is subjected to a distributed load w_0, concentrated load P and concentrated moment M_0. The length is specified L= 6 meters. The cross section of the first part and the third part are represented by identical circular beams with radius c. The cross-section in the second part is also circular but radius equals 2c. Material is aluminum; yield stress= 276 MPa; E= 69.9 GPa; required safety factor is k= 1.5. The allowable displacement $v_{allow=}$ L/400. Design the beam so that it satisfied strength condition, as well as stiffness condition. The moments of inertia of I-beams are given on pages 804-805 of the textbook, the number s is your serial number. Note: don't forget to depict FBD. Write equations to determine reactions. Use equivalent beam method. Please do not use SKYCIV software.

The copy of these assignment page must be included beneath the title page of the project.

The project ought to be presented in the reader-friendly format: For each problem, if the diagrams are not strictly below each other in the same scale as the Include sections of **Abstract** and **Conclusion**: Summarize what you learned from this personal communication project; provide also recommendation(s) to the lecturer on the project assignment and management.

P.S: Entire work must be neatly hand-written or typed. A grade "zero" will be assigned if not doing the project by yourself. Bonus of 5% for typed project but not computer-generated plots; 5% additional credit points for typed project and computer-generated plots. Students must submit the project via CANVAS (the submission methodology will be communicated later on). Each project submitted later than October 1, 2021, leads to 10 credits less, for each work day (this does not include weekends, Saturday and Sunday).

With wishes of success,

Isaac Elishakoff

Prof. Isaac Elishakoff and TA Abhishek Ratanpara