INTERMEDIATE STRENGTH OF MATERIALS

FALL 2021

Communication Project 2:

"APPLICATION OF THE DIRECT INTEGRATION METHOD OR OF DISCONTINUITY (SINGULARITY) FUNCTIONS TO STATICALLY INDETERMINATE UNIFORM OR STEPPED BEAM DESIGN"

Requirements and Deliverables

(assigned: Friday, October 1, 2021; submission date: Friday, October 15, 2020; 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 A25-A26 of the textbook, the number ***s*** is your serial number. You must depict the FBD. Write equations to determine reactions. Depict FBD with loadings in actual numbers. Use singularity functions, not the superposition principle. Using any computer software is not permissible.

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. You must depict the FBD. Write equations to determine reactions. Depict FBD with loadings in actual numbers. Use singularity functions, not the superposition principle. Using any computer software is not permissible.

(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 $v(x)$.

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; choose the material and the cross section. Find the maximum displacement of the beam. You must depict the FBD. Write equations to determine reactions. Depict FBD with loadings in actual numbers. Use singularity functions, not the superposition principle. Using any computer software is not permissible.

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. You must depict the FBD. Write equations to determine reactions. Depict FBD with loadings in actual numbers. Use singularity functions, not the superposition principle. Using any computer software is not permissible.

(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 $v(x)$.

Problems 5-6

Determine the maximum deflection in the beam subjected to following loading. The cross-section is given by American Standard Channel (pp. A27-28). 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? You must depict the FBD. Write equations to determine reactions. Depict FBD with loadings in actual numbers. Use singularity functions, not the superposition principle. Using any computer software is not permissible.

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 A25-26 of the textbook, the number s is your serial number. You must depict the FBD. Write equations to determine reactions. Depict FBD with loadings in actual numbers. Depict equivalent uniform beam and the parts of the original beam segments and their 'tailoring' process. Use singularity functions and equivalent uniform beam method. .Using any computer software is not permissible.

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. A grade "zero" will be assigned if not doing the project by yourself. No TYPED projects, please!

Students must submit the project to the secretary, Ms. Barbara, office Engineering West 190, and ask her to put a date-stamp. Her office is located in Engineering West building (or an "old" engineering building, in front of the library). Each project submitted later than October 15, 2021, 4 pm leads to 10 credits less, for each work day.

With wishes of success,

Isaac Elishakoff