MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

National aerospace university "Kharkiv Aviation Institute"

Department of aircraft strength

Course
Mechanics of materials and structures

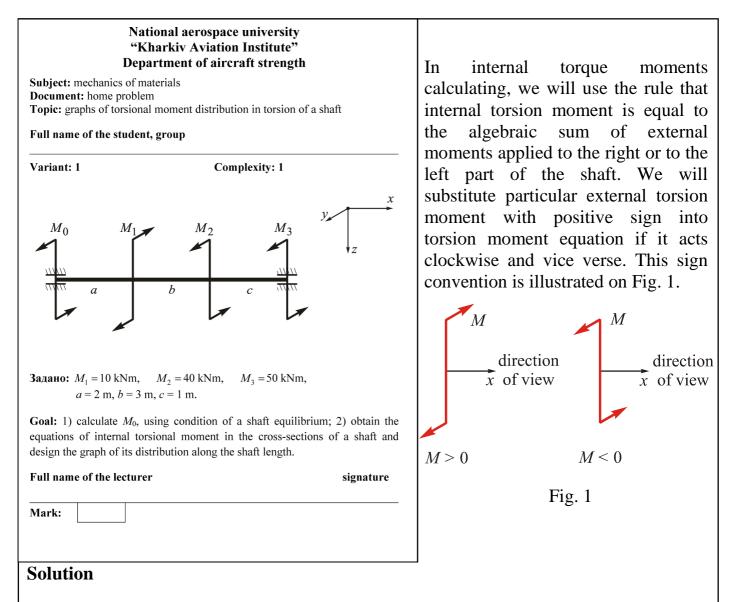HOME PROBLEM 3

Graphs of Torsional Moment Distribution in Torsion

Name of student:

Group:

Advisor:

Data of submission:

Mark:

Subject: mechanics of materials
Document: home problem
Topic: graphs of torsional moment distribution in torsion of a shaft

Full name of the student, group

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Variant: 1   **Complexity: 1**

Задано: $M_1 = 10$ kNm, $M_2 = 40$ kNm, $M_3 = 50$ kNm,
        $a = 2$ m, $b = 3$ m, $c = 1$ m.

Goal: 1) calculate M_0, using condition of a shaft equilibrium; 2) obtain the equations of internal torsional moment in the cross-sections of a shaft and design the graph of its distribution along the shaft length.

Full name of the lecturer   **signature**

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Mark:

In internal torque moments calculating, we will use the rule that internal torsion moment is equal to the algebraic sum of external moments applied to the right or to the left part of the shaft. We will substitute particular external torsion moment with positive sign into torsion moment equation if it acts clockwise and vice verse. This sign convention is illustrated on Fig. 1.

$M > 0$ $M < 0$

Fig. 1

Solution

1. Calculating unknown M_0 moment applying condition of the shaft equilibrium.
$$\sum M = M_0 + M_1 - M_2 + M_3 = 0 \rightarrow M_0 = -M_1 + M_2 - M_3 = -20 \text{ kNm}.$$
Note, that due to negative M_0 sign its original direction should be changed on opposite (see Fig. 2)

2. Selecting the arbitrary cross-sections at x-distances from the origin of each potion. In this solution, we will consider the equilibrium of right-situated parts of the rod (movement from right to left) (see Fig. 2).

3. Writing the equations of internal torque moment in an arbitrary cross-sections of each potion.

$I - I$ $(0 < x < c)$: $M_x^I(x) = +M_3 = +50$ kNm,

$II - II$ $(0 < x < b)$: $M_x^{II}(x) = +M_3 - M_2 = +50 - 40 = +10$ kNm,

$III - III$ $(0 < x < a)$: $M_x^{III}(x) = +M_3 - M_2 + M_1 = +50 - 40 + 10 = +20$ kNm.

4. Designing the graph of torque moment distribution (see Fig. 2).

Fig. 2