National aerospace university "Kharkiv Aviation Institute"

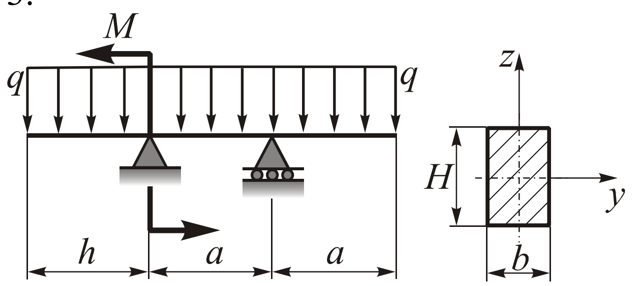
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 1

1. Parallel transfer of axes of inertia. Calculation of axial moments of inertia in parallel transfer of axes (proof).
2. Mechanical properties of structural materials and calculation of allowable stresses under the results of mechanical testing.

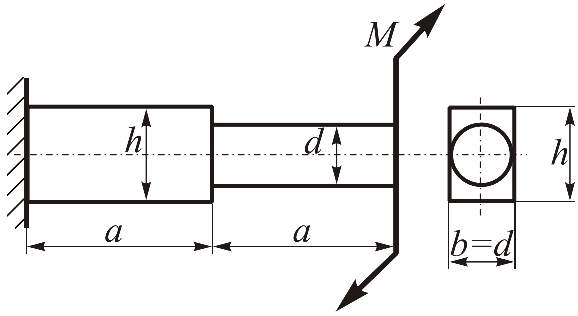
3.



Given: $a=3$ m, $q=5$ kN/m, $M=6$ kNm, $[\sigma]_c=200$ MPa, $[\sigma]_t=100$ MPa, $h/b=2$.

Aim: find dimensions of rectangular cross-section and draw the graphs $\sigma_x(z)$ and $\tau_{xz}(z)$ in critical section.

4.



Given: $h=1.5b$, $b=d=4\times10^{-2}$ m, $[\tau]=80$ MPa.

Aim: determine allowable value of external torsional moment $[M]$.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

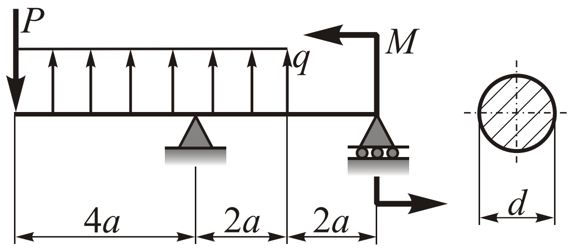
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 2

1. Rotation of axes of inertia. Calculation of principal axes position. Principal moments of inertia (proof).
2. Relationship between internal forces and stresses.

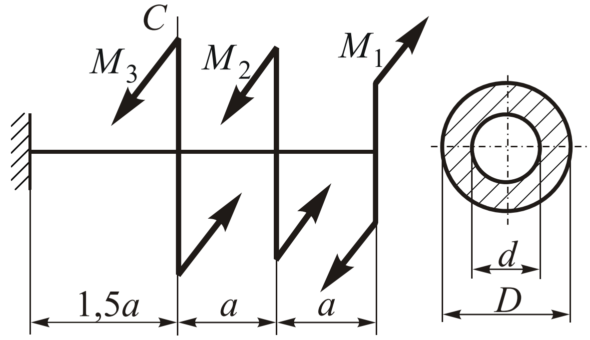
3.



Given: $a=0.5$ m, $q=P/l$, $l=2$ m, $M=6Pl$, $[\sigma]=100$ MPa, $d=2\times10^{-2}$ m.

Aim: determine $[P]$.

4.



Given: $a=0.3$ m, $\alpha=d/D=0.6$, $G=8\times10^{4}$ MPa, $[\theta]=1$ degree/m, $M_1=8$ kNm, $M_2=20$ kNm, $M_3=10$ kNm.

Aim: determine diameters d and D of the shaft and angle of twist of C-section

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

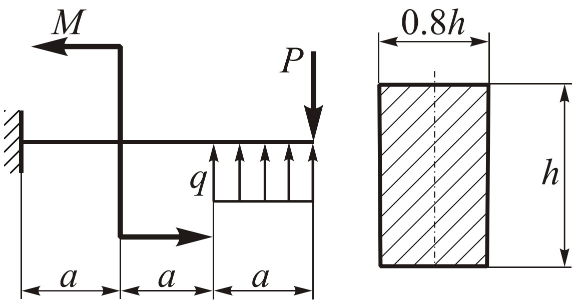
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 3

1. Stress state at a point of deformable solid. Formulae for stresses acting on two mutually perpendicular planes of general position in plane stress state (proof).
2. Factors of material ductility (plasticity) in tension.

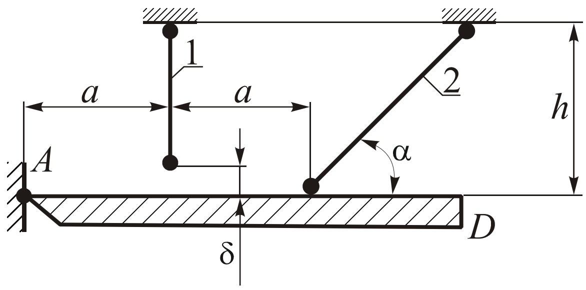
3.



Given: $a=1$ m, $q=2$ kN/m, $P=6$ kN, $M=4$ kNm, $[\sigma]_t=[\sigma]_c=200$ MPa.

Aim: determine h .

4.



Given: *AD – absolutely rigid bar,* $a=h=1.0$ m, $\alpha=30°$, $A_1=A_2=A=1\times10^{-4}$ m^2, $E_1=E_2=2\times10^5$ MPa, $\delta=5\times10^{-4}$ m.

Aim: calculate stresses in rods *1* and ***2*** after assembly.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

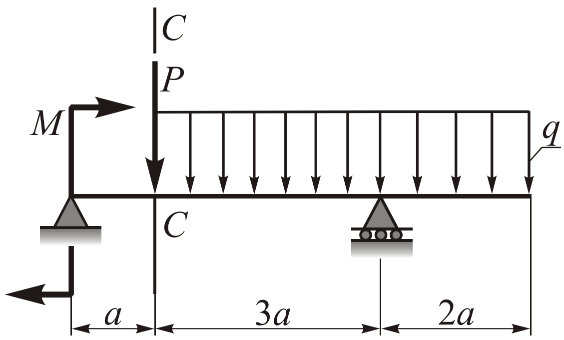
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 4

1. Plane stress state. Proof of the formulae for principal stresses and principal planes position.
2. Principle of superposition.

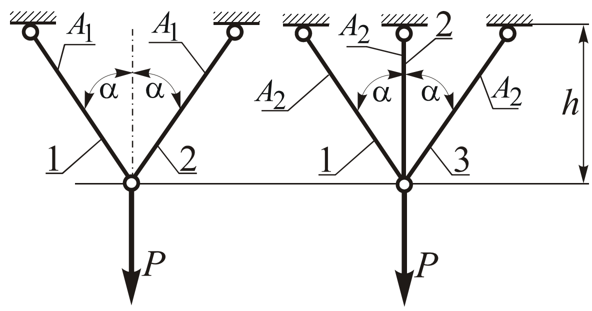
3.



Given: $a=1\ m$, $q=5\ kN/m$, $P=12\ kN$, $M=6\ kNm$, $[\sigma]_c=200\ MPa$, $[\sigma]_t=150\ MPa$

Aim: determine the number of I-beam section and calculate τ_{max} in *C-section*.

4.



Given: $h=1\ m$, $P=20kN$, $\alpha=30°$, $[\sigma]=160\ MPa$, $\rho=7.8\times10^3\ kg/m^3$.

Aim: find A_1, A_2 for two variants of rod system and compare their masses.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

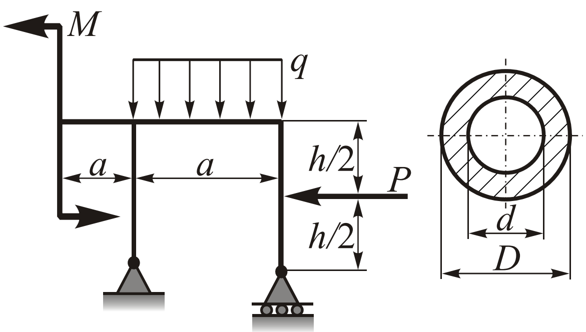
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 5

1. Graphical solution of direct and inverse problems of plane stress state (Mohr’s circles).
2. External and internal forces, their types, units. Difference between external and internal forces. Internal stress as the measure of internal force distribution in cross-section.

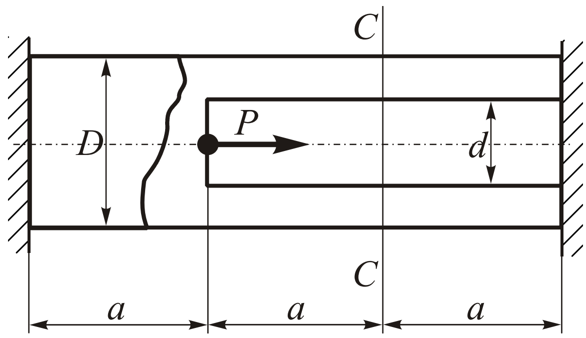
3.



Given: $a=1$ m, $h=2$ m, $q=2$ kN/m, $P=4$ kN, $M=8$ kNm, $[\sigma]_c=200$ MPa, $[\sigma]_t=100$ MPa, $d/D=0{,}8$.

Aim: draw graphs N_x, Q_z, M_y;
calculate D and d for the most loaded cross-section.

4.



Given: $a=1.0$ m, $P=60$ kN, $D=12\times10^{-2}$ m, $d=6\times10^{-2}$ m, $E=2\times10^{5}$ MPa.

Aim: draw graph $N_x(x)$; determine displacement of C-section.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

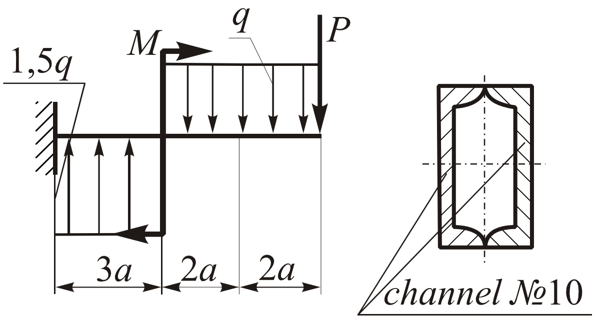
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 6

1. Generalized Hooke's law for principal planes (proof).
2. Rational orientation of cross-section relative to plane of loading in plane bending (examples).

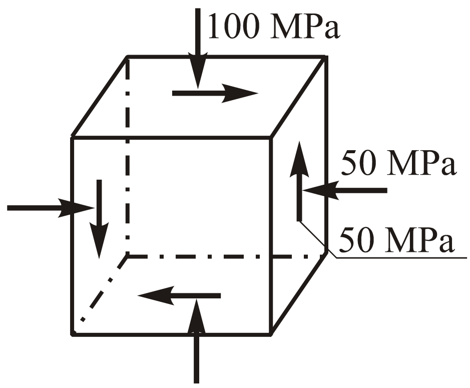
3.



Given: $a=2$ m, $P=2qa$, $M=4qa^2$, $[\sigma]_c=200$ MPa, $[\sigma]_t=150$ MPa.

Aim: determine $[q]$.

4.



Given: $E=2\times10^5$ MPa, $\mu=0,3$.

Aim: find position of principal planes.Calculate principal stresses, maximum shear stresses and also relative change in volume ε_V.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

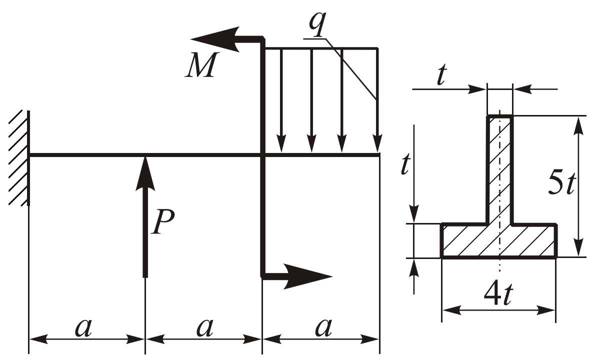
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 7

1. Strain state at a point of elastic deformable solid. Relationship between components of strain state and displacements *U, V, W* at a point (Cauchy relationships)
2. Sectional moduli of cross-sections (examples of calculation).

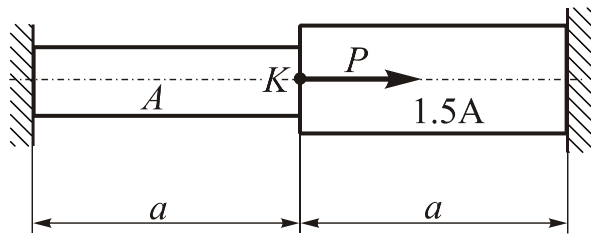
3.



Given: $a=1$ m, $M=30$ kNm, $q=40$ kN/m, $P=20$ kN, $t=4\times10^{-2}$ m, $[\sigma]_t=100$ MPa, $[\sigma]_c=200$ MPa.

Aim: calculate σ_{max} and check the strength of the beam.

4.



Given: $a=1$ m, $P=80$ kN, $[\sigma]_c=160$ MPa, $[\sigma]_t=100$ MPa.

Aim: calculate cross-sectional area *A*, and also displacement of point *K*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

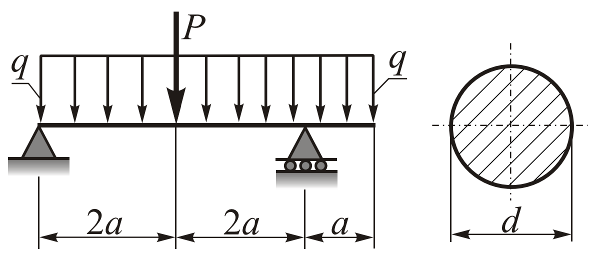
Degree B. Sc.   Branch of education: 1001   **Aerospace Engineering**   Semester **III**

Course **"Mechanics of materials"**

Examination card № 8

1. Tension-compression of the rod. Hypothesis of plane sections. Formula for normal stresses (proof). Condition of strength.
2. Axial and polar moments of inertia and also product of inertia for plane figures. Relationship between axial and polar moments of inertia.

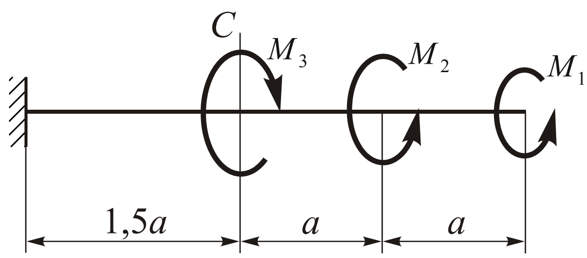
3.



Given: *a=1 m, P=3qa,* $d=8\times10^{-2}$ *m,* $[\sigma]_t=180$ *MPa,* $[\sigma]_c=200$ *MPa.*

Aim: draw graphs $Q_z(x)$, $M_y(x)$ and determine allowable intensity of distributed load *[q]*.

4.



Given: $[\tau]=100$ *MPa,* $G=8\times10^4$ *MPa,* $[\psi]=1$ *degree/m, a=1.0 m, d/D=0.8,* $M_1=1.5$ *kNm,* $M_2=4.5$ *kNm,* $M_3=3$ *kNm,*

Aim: draw graph $M_x(x)$, calculate diameters of hollow shaft and also angle of twist of C-section

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,**   21 November**,** 2011

Head of Department, Doctor of Science, Professor   **Fomichov P.O.**

Examiner   **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

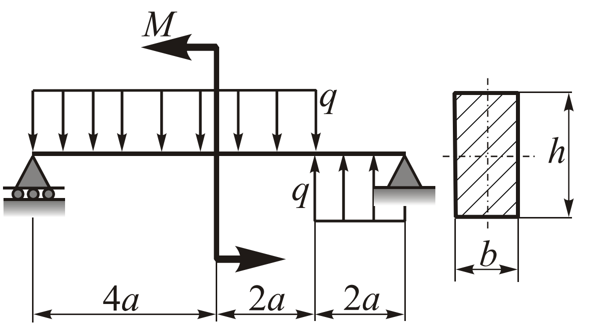
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 9

1. Tension-compression of prismatic rod. Deformations and displacements of cross-sections. Condition of rigidity.
2. Principal axes of inertia. Extremity of geometrical properties of cross-section relative to principal axes.

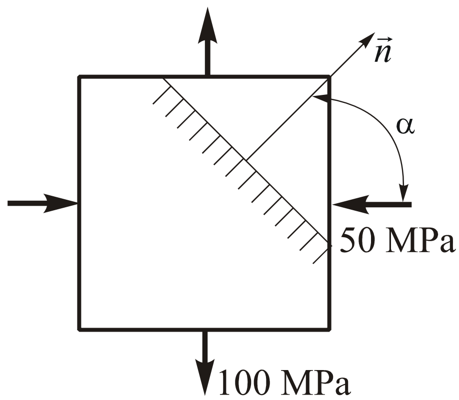
3.



Given: $a=2$ m, $M=2qa^2$, $h=10\times10^{-2}$ мм, $h/b=2$, $[\sigma]_t=200$ MPa, $[\sigma]_c=300$ MPa.

Aim: determine $[q]$.

4.



Given: $E=2\times10^5$ MPa, $\mu=0.3$, $\alpha=30°$.

Aim: calculate stresses on inclined α-plane and also relative change in volume ε_V.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

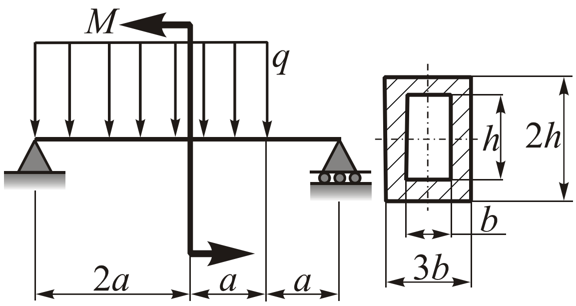
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 10

1. Statically indeterminate rod systems in tension-compression (an example of solving the problem of opening of static indeterminacy).
2. Method of sections and calculation of internal forces in cross-section, knowing external forces applied to elastic solid.

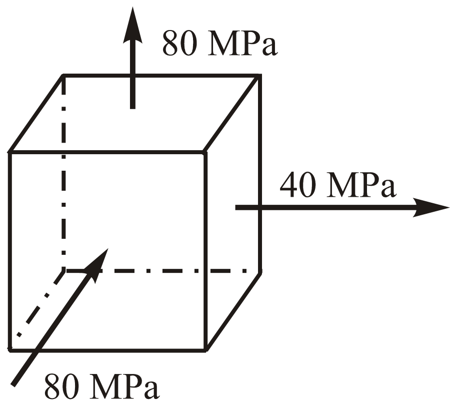
3.



Given: $a=1\ m$, $b=0.04\ m$, $h=0.08\ m$, $M=2qa^2$, $[\sigma]_t=140\ MPa$, $[\sigma]_c=200\ MPa$.

Aim: determine $[q]$.

4.



Given: $\mu=0{,}28$, $E = 2\cdot 10^{11}\ Pa$.

Aim: determine strains of the edges and relative change in volume ε_v.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

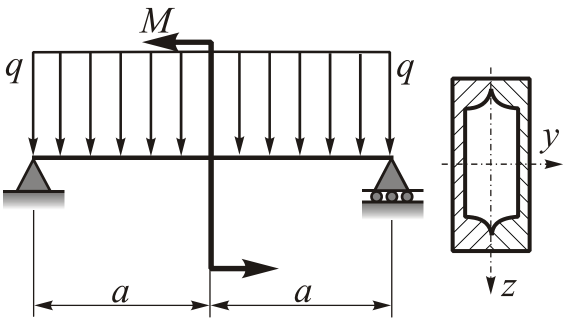
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 11

1. Thermal stresses in the rods and statically indeterminate rod systems in tension-compression. Method of calculation (an example).
2. Allowable stress and its calculation in result of mechanical test.

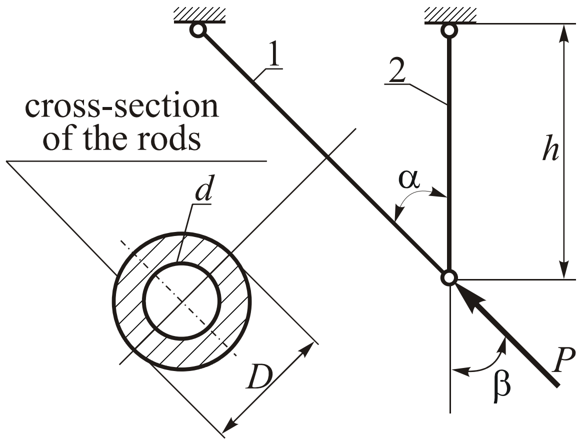
3.



Given: a=3 m, M=10 kN·m, q=2kN/m, $[\sigma]$=180 MPa.

Aim: determine № of channel section.

4.



Given: $D=3\times10^{-2}$ m, $d=2.4\times10^{-2}$ m, $\alpha=30°$, $\beta=60°$, $[\sigma]$=75 MPa .

Aim: determine $[P]$.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

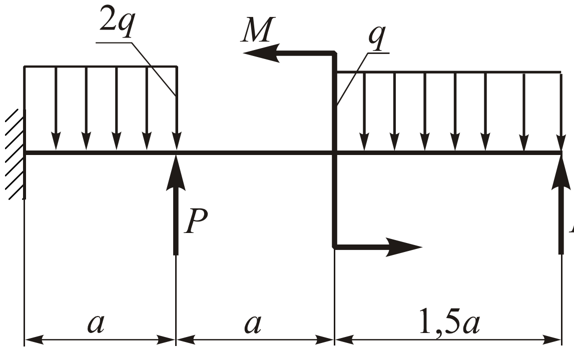
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 12

1. Assembly stresses in elements of statically indeterminate rod systems in tension-compression.
2. Maximum shearing stresses. Orientation of the planes of maximum shear stresses relative to principal planes and corresponding normal stresses.

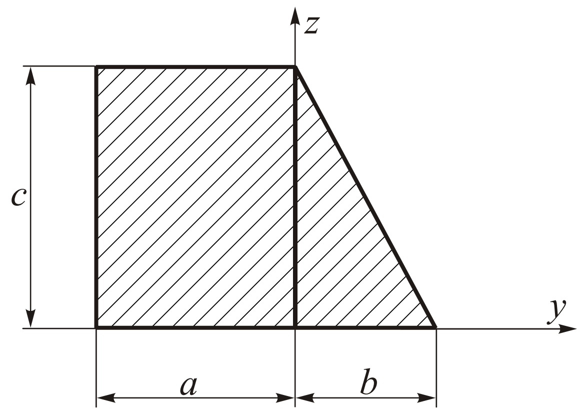
3.



Given: a=2 м, $P=4qa$, $M=qa^2$, $[\sigma]_c=200$ MPa, $[\sigma]_t=160$ MPa, I № 20.

Aim: determine allowable intensity of distributed load $[q]$.

4.



Given: $b=2\times10^{-2}$ m, $c=8\times10^{-2}$ m.

Aim: calculate value of a from the viewpoint that first moment of area relative to z axis equals to zero. Determine I_y, I_z, I_{yz}.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

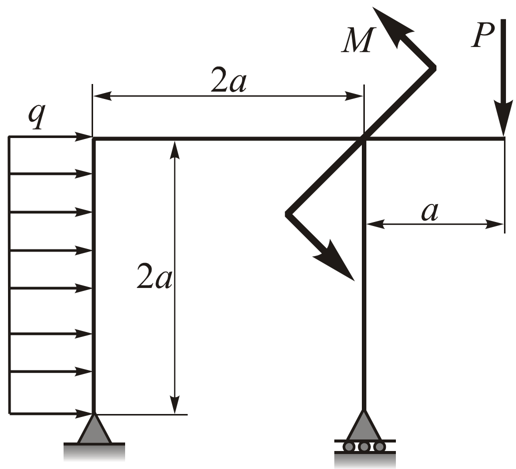
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 13

1. Torsional deformation. Proof of torsional formula (calculation of shear stresses in round solid and hollow shafts). General assumptions and hypotheses. Graph of shear stress distribution in cross-section, position of dangerous point, calculation of maximum stresses.
2. Method of sections. Determination of internal forces, knowing external ones (examples for three simple deformations).

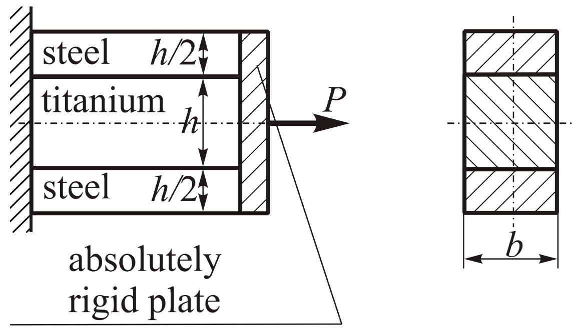
3.



Given: $a=2$ м, $P=6$ kN, $M=10$ kNm, $q=3$ kN/m, $[\sigma]_t=200$ MPa, $[\sigma]_c=250$ MPa.

Aim: draw graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$; find number of I-beam section.

4.



Given: Composite rod of rectangle cross-section consists of steel and titanium parts:

$b=5\times10^{-2}$ m, $P=50$ kN,

$[\sigma]_{steel}=200$ MPa, $[\sigma]_{titan}=600$ MPa,

$E_{steel}=2\times10^5$ MPa, $E_{titan}=1\times10^5$ MPa .

Aim: find h.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

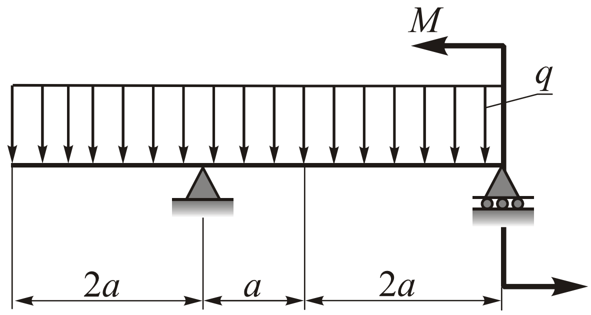
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 14

1. Torsional deformation. Proof of the formula for angle of twist of round solid and hollow shafts. Condition of rigidity.
2. Hooke's law in tension-compression. Hooke's law in pure shear. Relationship between *E* and *G* moduli.

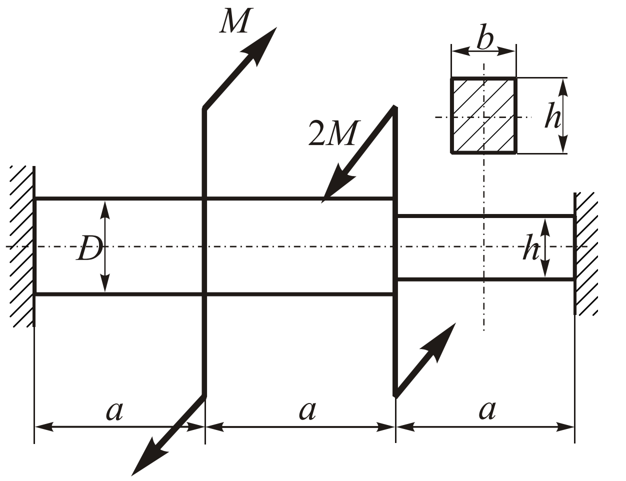
3.



Given: a=2 m, $M=2qa^2$, $[\sigma]_t$=100 MPa, $[\sigma]_c$=200 MPa, I №10 .

Aim: determine allowable value of $[q]$.

4.



Given: $D=8\times10^{-2}$ m, $b=3.0\times10^{-2}$ m, $h=4.5\times10^{-2}$ m, M=10 kNm, $[\tau]$=80 MPa.

Aim: check the strength of the shaft.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

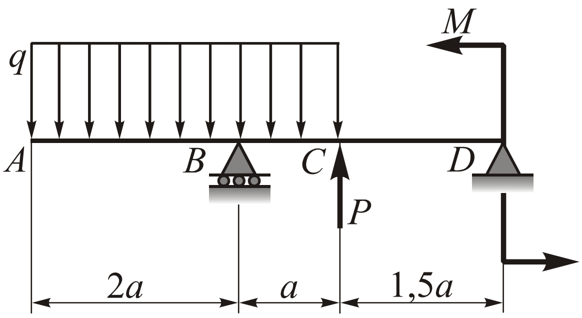
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 15

1. Torsion of the shaft with rectangle cross-section. Shear stress formula. Stress distribution in cross-section. Condition of strength. Particularities of shear stress calculation in thin-walled shafts of opened cross-section.
2. Force-elongation diagram of ductile and brittle materials. Stress-strain diagram. Mechanical properties of material determined in result of tension test.

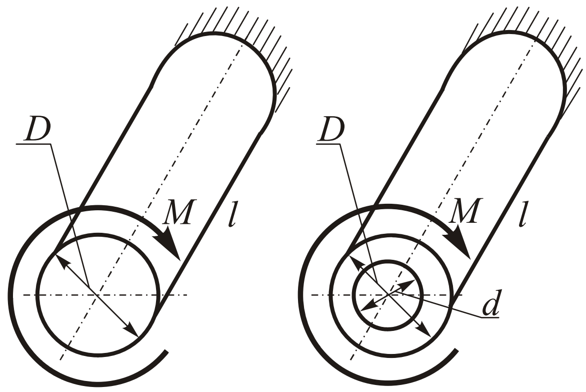
3.



Given: a=2 m, P=10 kN, M=3 kNm, $[\sigma]_t$=180 MPa, $[\sigma]_c$=200 MPa, q=2 kN/m .

Aim: determine № of I-beam section and calculate τ_{max} .

4.



Aim: estimate decrease of solid shaft allowable external torsional moment [M] relative to hollow one.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

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Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

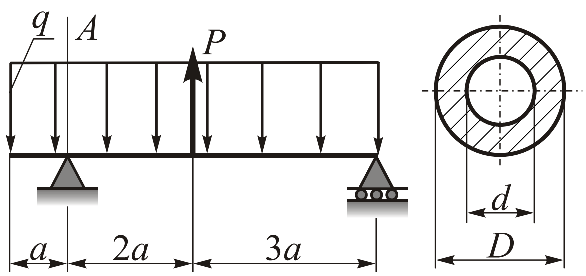
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 16

1. Torsion of shafts with rectangle cross-section. Formula for angle of twist and condition of rigidity. Particularities of angle of twist calculation for shafts of thin-walled opened cross-section.
2. Properties of material strength. Allowable stress as result of mechanical testing of structural material.

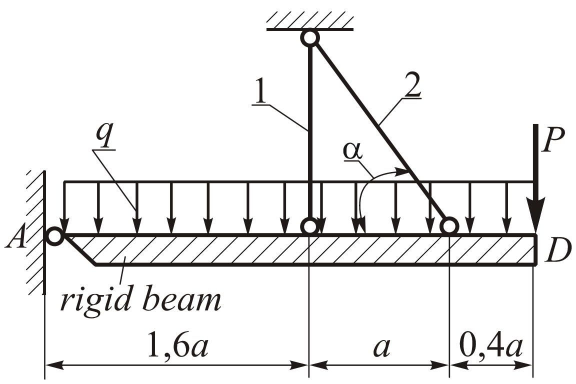
3.



Given: a=1 m, P=4 kN, q=2 kN/m, d/D=0.8, $[\sigma]_p$=100 MPa, $[\sigma]_c$=200 MPa.

Aim: calculate D and draw the graph $\sigma_x(z)$ in A-section.

4.



Given: a=2 m, P=60 kN, q=10 kN/m, $[\sigma]$=140 MPa, $A_1=A_2=A$, $\alpha=60°$, bar AD –absolutely rigid.

Aim: 1. Determine normal forces in *1*, *2* rods; 2. Calculate their cross-sectional area A.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

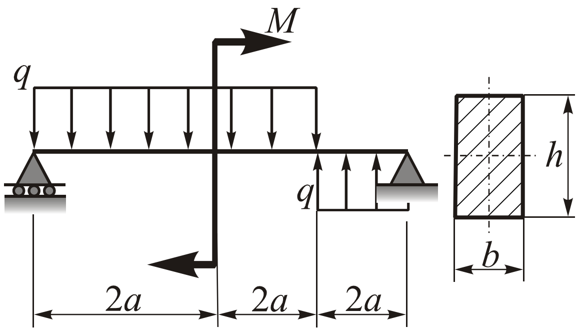
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 17

1. Torsion of thin-walled shafts with closed profile. Calculation of shear stresses. Condition of strength.
2. Generalized Hooke's law and its application for calculation of relative change in elastic material volume.

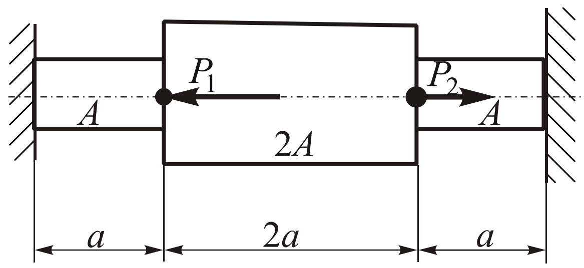
3.



Given: $a=1$ m, $M=2qa^2$, $h=15\times10^{-2}$ m, $h/b=2$, $[\sigma]=100$ MPa.

Aim: determine $[q]$.

4.



Given: $a=0.1$ m, $P_1=20$ kN, $P_2=10$ kN, $[\sigma]_c=160$ MPa, $[\sigma]_t=100$ MPa.

Aim: draw graphs $N_x(x)$ $\sigma_x(x)$; determine cross-sectional area A.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

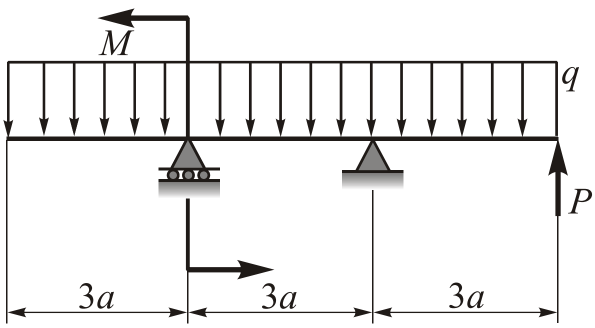
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 18

1. Torsion of the shafts with round solid cross-section. Proof of angle of twist formula. Condition of rigidity.
2. Explain the terms: "combined stress-state", "stress tensor", "strain tensor".

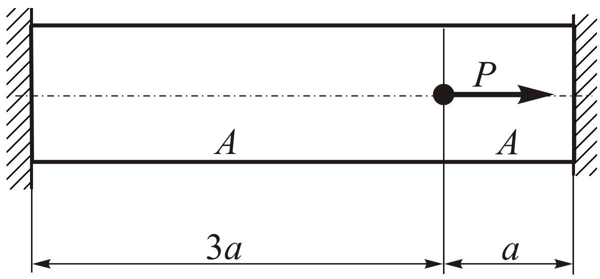
3.



Given: $a=1\ m$, $M=4qa^2$, $P=5qa$, $[\sigma]=200\ MPa$, I №18.

Aim: determine $[q]$.

4.



Given: $[\sigma]=200\ MPa$, $A=10\times10^{-4}\ m^2$, $a=2\ m$, $E=2\times10^5\ MPa$, $\alpha_t=1.25\times10^{-5}\ 1/K$.

Aim: determine change of $[P]$ after $50\ K$ change of rod temperature.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

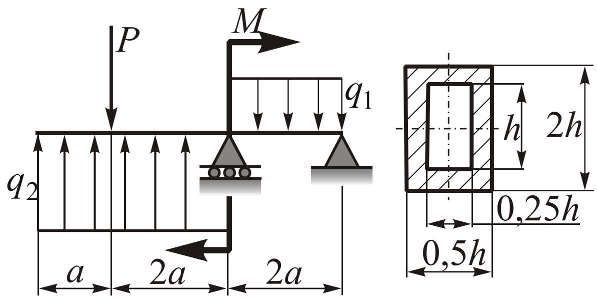
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 19

1. Opening of static indeterminacy of shaft in torsion (describe the example).
2. Define the concepts of principal plane and principal stress. Types of stress state in vicinity of a point.

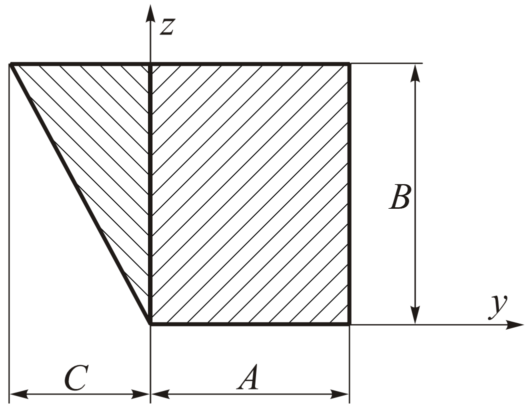
3.



Given: $a=1$ m, $M=4$ kNm, $P=6$ kN, $q_1=2$ kN/m, $q_2=1$ kN/m, $[\sigma]=100$ MPa.

Aim: determine h.

4.



Given: $A=10\times10^{-2}$ m, $B=6\times10^{-2}$ m.

Aim: calculate value of C from the viewpoint that first moment of area relative to z axis equals to zero. Determine I_y, I_z, I_{yz}.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

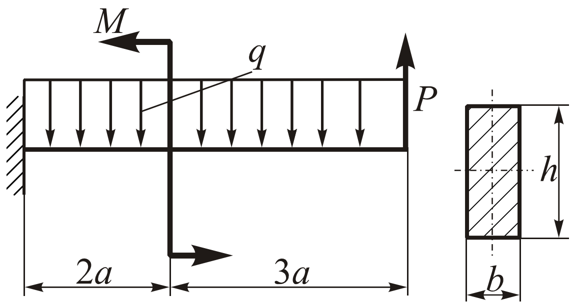
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 20

1. Types of bending. Bending formula for prismatic beam in pure plane bending (proof). Condition of strength.
2. Principal hypotheses and assumptions in mechanics of materials.

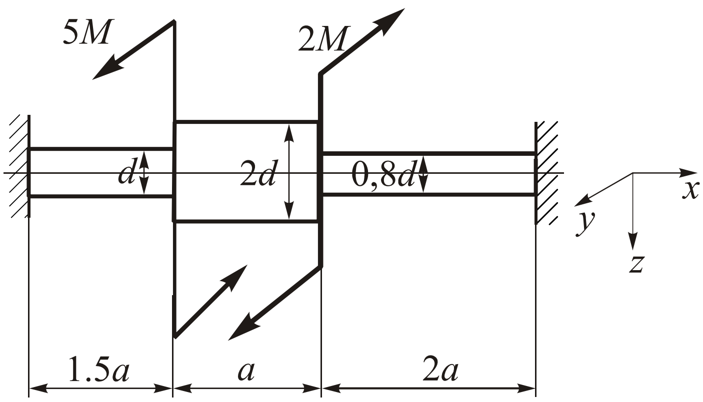
3.



Given: *a=1 m, h=1.25b, P=4 kN,*
M=6 kNm, q=2 kN/m,
[σ]=120 MPa.

Aim: determine ***b*** and ***h*** dimensions of beam cross-section.

4.



Given: $a=0.1$ m, $d=4\times10^{-2}$ m, $[\tau]=80$ MPa,
$[\varphi]=0.5$ degree/m, $G=8\times10^{4}$ MPa.
M=10 *kNm*

Aim: determine ***d***.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

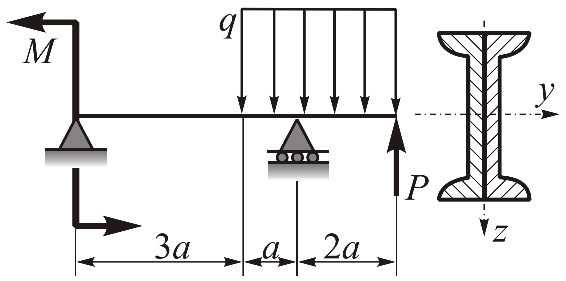
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 21

1. Transverse plane bending of prismatic beam. Proof of Juravsky formula for shear stress distribution over the cross-section. Proof of possibility of pure bending formula use for studying the normal stress distribution in transverse bending.
2. Concept of strain energy in elastic deformation.

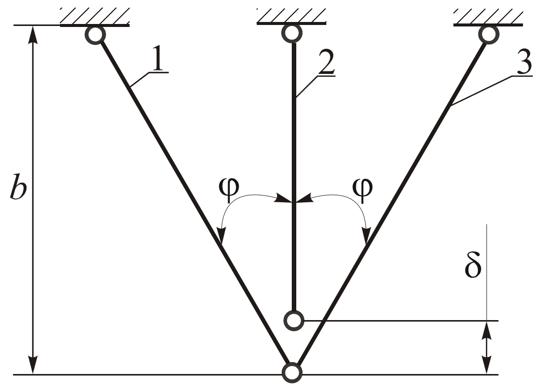
3.



Given: *a=1 m, q=10 kN/m, M=6 kNM, P=10 kN,* *[σ]=180 MPa.*

Aim: determine the number of channel section for composite beam.

4.



Given: $b=10\times10^{-2}$ м, $\delta=0.2\times10^{-3}$ m, $A_1=A_2=A_3=2\times10^{-4}$ м^2, $E_1=E_2=E_3=2\times10^5$ MPa, $\varphi=30°$.

Aim: calculate stresses in rods after assembly.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

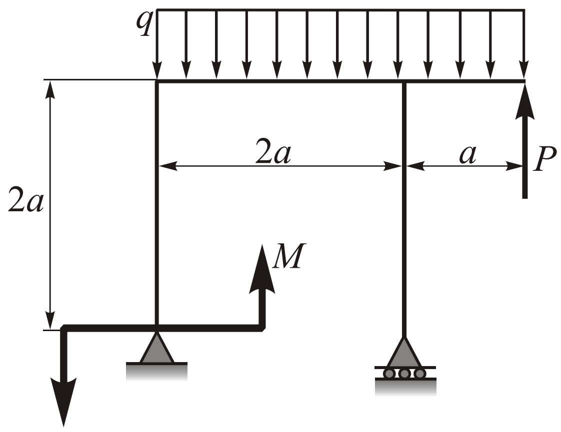
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 22

1. Differential relationships between $q(x)$, $Q_z(x), M_y(x)$ in plane bending (proof) and their application for checking the graphs of internal forces distribution (an example).
2. Hypothesis of plane sections and its use in proof of general formulae of tension-compression, torsion, bending.

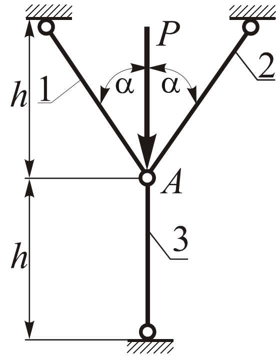
3.



Given: *a=0.5 m, M=6 kNm, q=18 kN/m, P=10 kN, [σ]=200 MPa.*

Aim: draw graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$; determine the diameter of round cross-section.

4.



Given: *h=1 м, $A_1=A_2=A$, $A_3=2A$, $\alpha=30°$, [σ]=140 MPa, P=40 kN, $E_1=E_2=E_3=E=2\times10^5$ MPa .*

Aim: determine cross-sectional area *A* and vertical displacement of the hinge *A*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

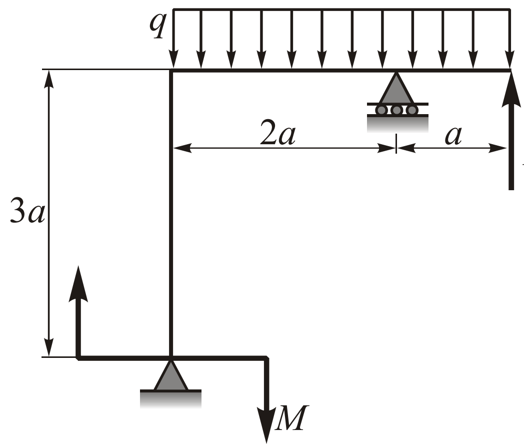
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 23

1. Proof of differential equation of beam deflected curve. Determination of constants of integration.
2. Poisson's ratio and the method of its experimental determination.

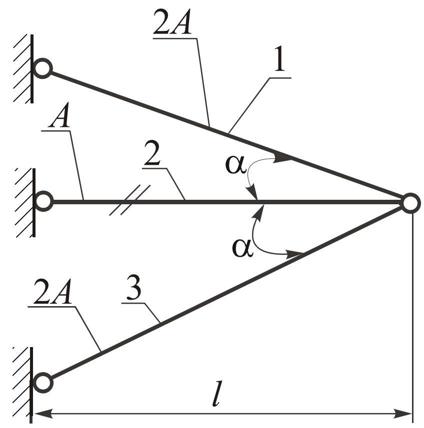
3.



Given: a=1 m, M=6 kNm, q=10 kN/m, P=10 kN, $[\sigma]$=160 MPa.

Aim: draw graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$; determine the diameter of the frame.

4.



Given: rod 2 is heated at 60 K, $\alpha_t=1.25\times10^{-5}$ 1/K, $E=2\times10^{5}$ MPa, $A=2\times10^{-4}$ m^2, l=2 m, α=30°.

Aim: determine stresses in the rods *1*, *2*, *3*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

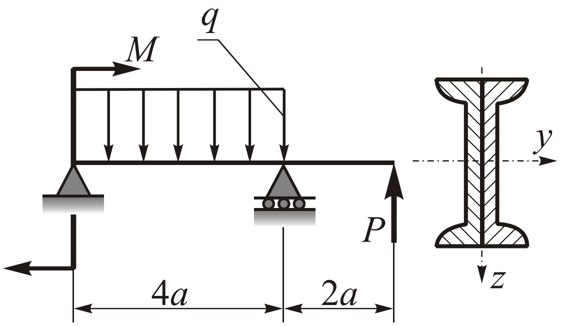
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 24

1. Generalized Hooke's law. Proof of its equations in the terms of principal stresses.
2. Geometrical and physical sense of modulus of elasticity in tension-compression. Method of its experimental determination.

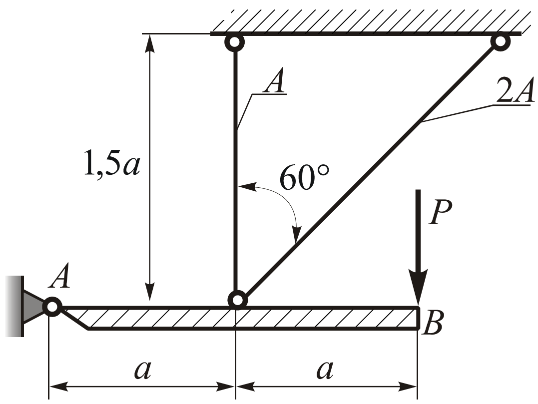
3.



Given: *a=1 м, q=10 kN/m, M=12 kNm, P=10 kN, [σ]=180 MPa.*

Aim: draw graphs $Q_z(x)$, $M_y(x)$ and determine № of channel in composite section. Calculate τ_{max} in critical section.

4.



Given: *a=1 m,* $A=10\times10^{-4}$ *m*^{2}*,* $[\sigma]$ *=200 MPa.*

Aim: calculate allowable value of *P* force.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

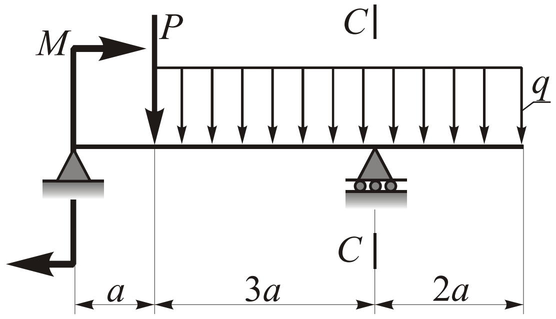
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 25

1. Bending formula in pure bending (proof). Normal stress distribution, critical points of cross section, condition of strength.
2. Geometrical and physical sense of shear modulus of elasticity. Method of its experimental determination.

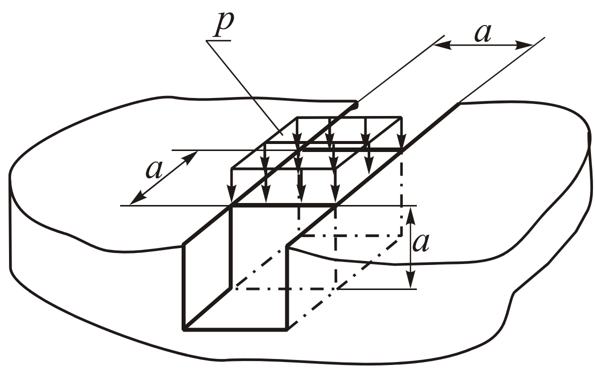
3.



Given: *a=1 m, q=2 kN/m, P=12 kN, M=6 kNm,* $[\sigma]$*=200 MPa.*

Aim: determine number of I-beam section and τ_{max} in ***C*** section

4.



Given: $a=10\times10^{-3}$ *m, P=100 MPa,* $E=1\times10^{5}$ *MPa,* $\mu=0.32$.

Aim: determine stresses on the faces of the element and also strains of its edges.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

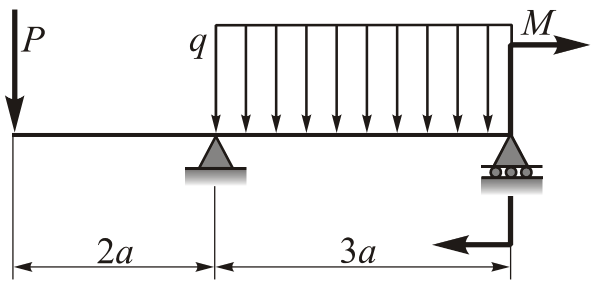
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 26

1. Shear stresses in transverse bending. Proof of Juravsky formula.
2. Tension tests of materials and calculation of allowable stresses.

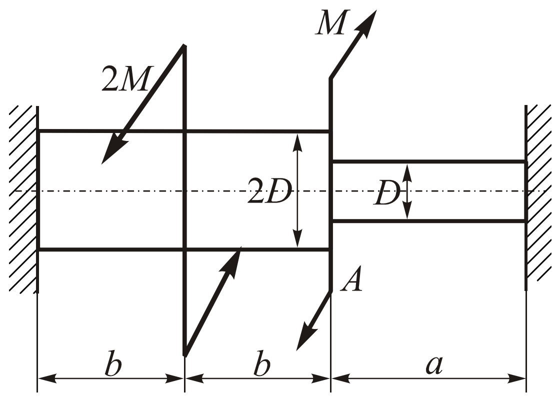
3.



Given: $a=0.5$ m, $P=6$ kN, $q=2$ kN/m, $M=4$ kNm, $[\sigma]=200$ MPa.

Aim: determine diameter of round cross-section and draw the graph $\tau(z)$ in *A*-section.

4.



Given: $a=1.8$ m, $b=1.2$ m, $M=30$ kNm, $G=8\times10^4$ MPa, $[\psi]=0.5$ degree/m.

Aim: determine *D* and angle of twist of *A*-section.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

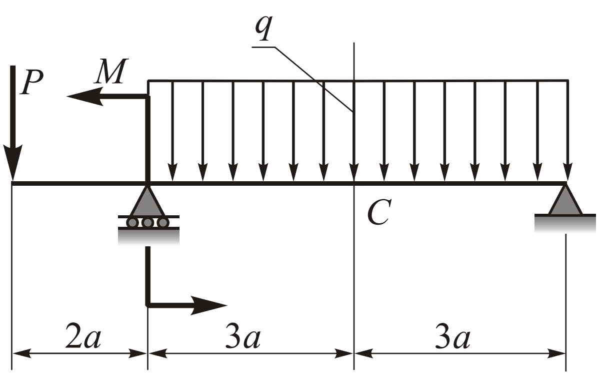
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 27

1. Stresses at an arbitrary point of cross-section in plane transverse bending. Proof of the bending formula and estimation of shear stress distribution in round solid and hollow cross-sections.
2. First moment of area. Central axes and coordinates of geometrical center (centroid) of cross-section.

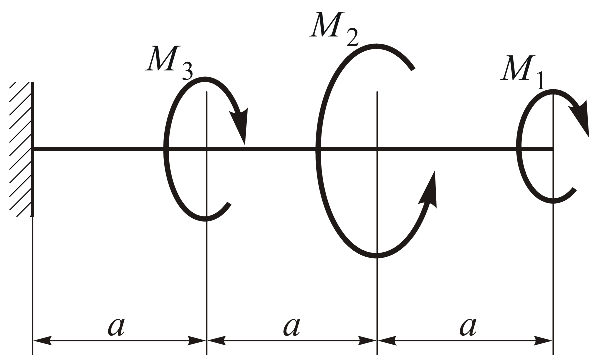
3.



Given: a=0.5 m, P=20 kN, M=40 kNm, q=20 kN/m, $[\sigma]$=100 MPa.

Aim: determine number of I-beam section and draw graph $\sigma_x(z)$ in C-section. Calculate τ_{max}.

4.



Given: a=0.4 m, M_1=20 kNm, M_2=80 kNm, M_3=10 kNm, $[\tau]$=100 MPa, $G=8\times10^4$ MPa, $[\psi]$=0.5 degree/m.

Aim: determine diameter of the shaft and draw the graph of angle of twist distribution.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

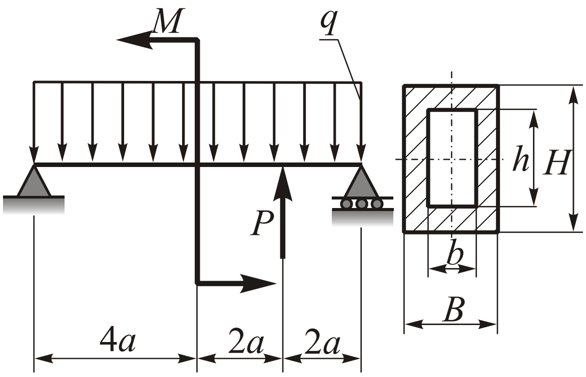
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 28

1. Formula of shear stresses in torsion of solid shaft (proof). Condition of strength in torsion.
2. Methods of experimental study of strains.

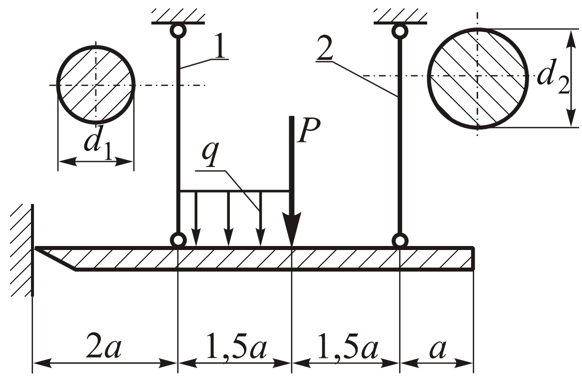
3.



Given: *a=1 m, M=2qa², P=4qa, H=8×10⁻² m, h=6×10⁻² m, B=6×10⁻² m, b=4×10⁻² m, [σ]=100 MPa.*

Aim: determine *[q]*.

4.



Given: $a=1$ m, $P=100$ kN, $d_1/d_2=0.8$, $q=20$ kN/m, $[\sigma]=100$ MPa.

Aim: determine d_1, d_2.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

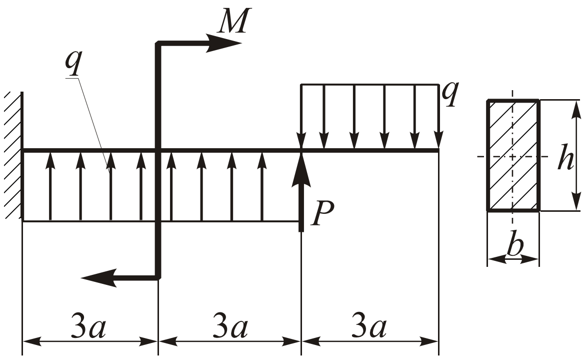
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 29

1. Methods of experimental study of mechanical properties of structural materials. Properties of material strength and ductility (plasticity).
2. Features of strength analysis of statically indeterminate rod systems in tension-compression.

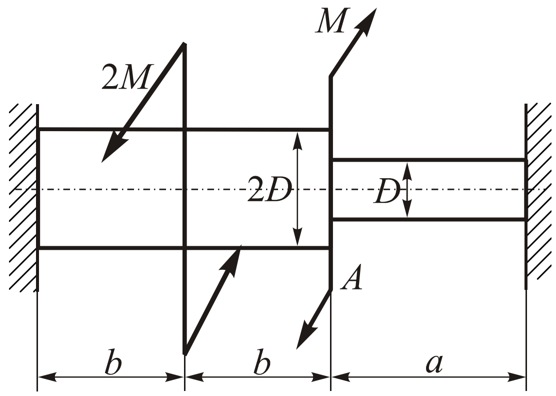
3.



Given: $a=0.25$ m, $M=10$ kNm, $q=2$ kN/m, $P=10$ kN, $b=5\times10^{-2}$ m, $h/b=2$, $[\sigma]=100$ MPa.

Aim: check the strength of the beam and draw graphs $\sigma_x(z)$ and $\tau_{xz}(z)$ in rigid support.

4.



Given: $a=2$ m, $b=1.5$ m, $M=30$ kNm, $[\tau]=80$ MPa, $G=8\times10^{4}$ MPa,

Aim: calculate D and angle of twist of A-section.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

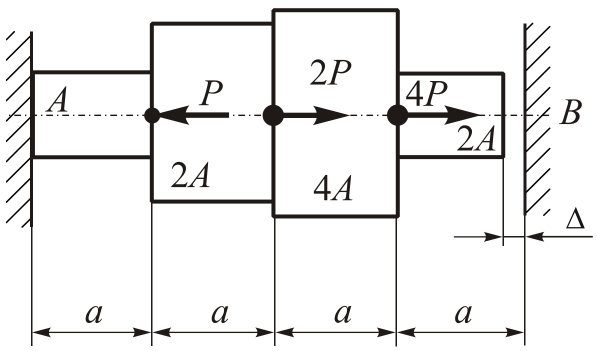
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 30

1. Proof of the formula for shear stress distribution over the cross-section of a beam in plane transverse bending..
2. Show the difference between “force-elongation” and “stress-strain” diagrams.

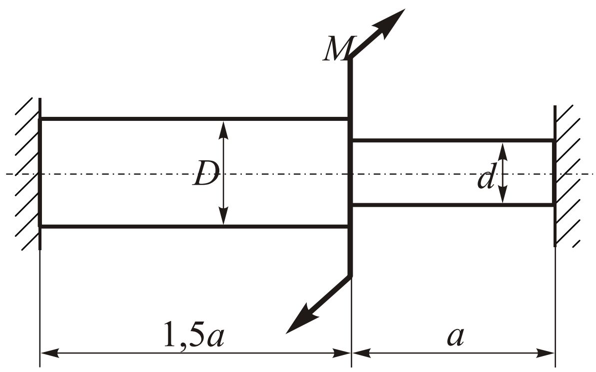
3.



Given: a=0.5 m, A=10 cm^2
$[\sigma]$=100 MPa, P=20kN,
Δ=0.2 mm.

Aim: check the strength.

4.



Given: a=0.6 m, $D=4\times10^{-2}$ m, d/D=0.8,
$[\tau]$=90 MPa.

Aim: check the strength of the shaft.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

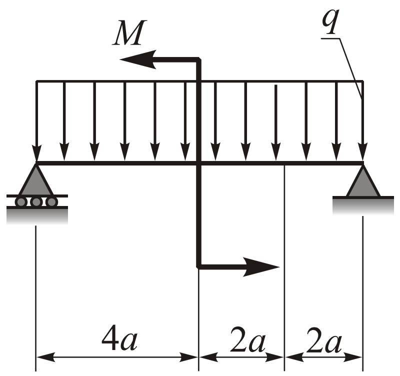
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 31

1. Method of stress analysis of statically indeterminate shafts in torsion (an example).
2. Allowable stress and its determination on the basis of tensile test.

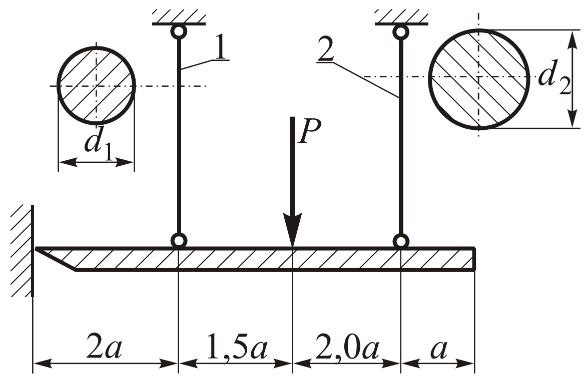
3.



Given: $a=1\ m$, $M=2qa^2$, $[\sigma]=100\ MPa$, cross-section – I-beam № 20.

Aim: calculate $[q]$.

4.



Given: $a=1\ m$, $P=100\ kN$, $d_1/d_2=0.8$, $[\sigma]=100\ MPa$.

Aim: determine d_1, d_2.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

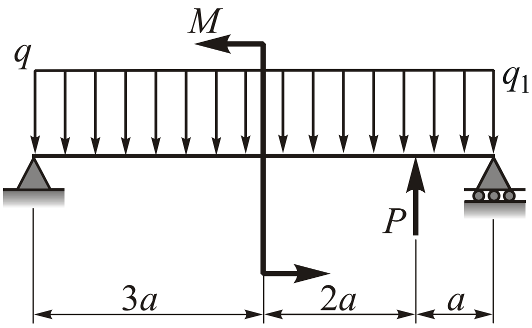
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 32

1. Proof of the formula for acting stresses in pure plane bending and also method of strength analysis of the beam in pure plane bending.
2. Poisson’s ratio and method of its experimental determination.

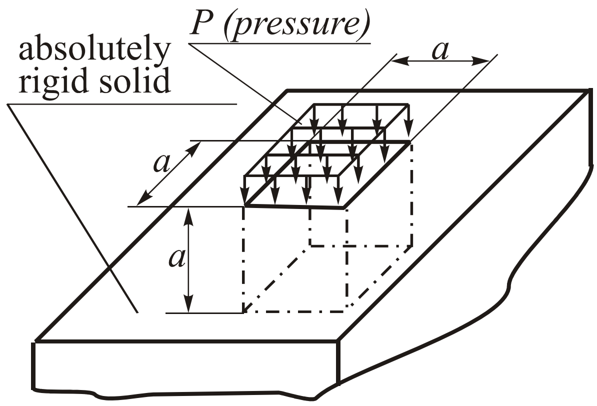
3.



Given: $a=1$ m, $M=40$ kNM, $P=10$kN, $[\sigma]=200$ MPa, $q=20$ kN/m.

Aim: determine № of I-beam section in plane bending.

4.



Given: $a=0.1\times10^{-2}$ m, $P=100$ MPa, $\mu=0.28$, $E=2\times10^{5}$ MPa.

Aim: calculate relative change in volume of elastic element put into absolutely rigid plate without gaps.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

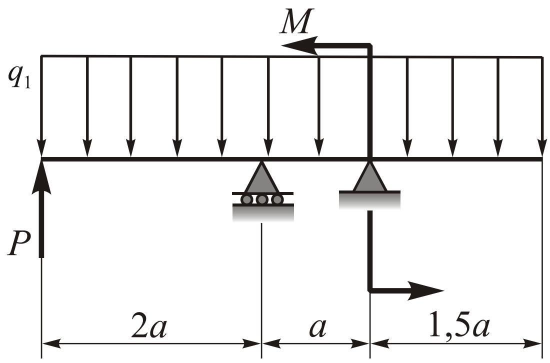
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 33

1. Experimental investigation of mechanical properties of structural materials. Factors of material ductility and strength.
2. Torsion of rectangle shafts. Critical points and stresses, condition of strength.

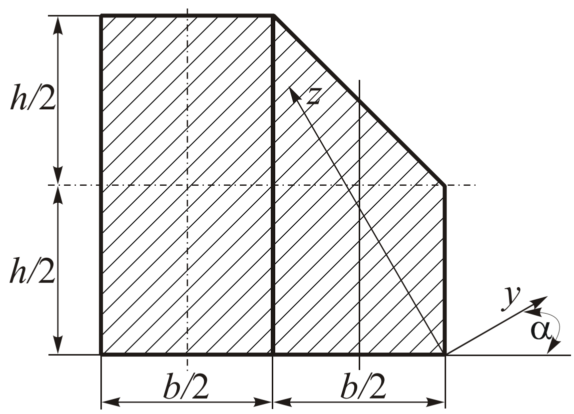
3.



Given: *a=1 m, M=20 kNm, P=20kN, q=30kN/m* *[σ]=200 MPa,*

Aim: determine number of I-beam section and calculate τ_{max} .

4.



Given: $b=12\times10^{-2}$ m, $h=12\times10^{-2}$ m, $\alpha=30°$.

Aim: calculate axial moments of inertia and also product of inertia of the section relative to ***y, z*** axes.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner (підпис) **Demenko V.F.** (підпис)

National aerospace university "Kharkiv Aviation Institute"

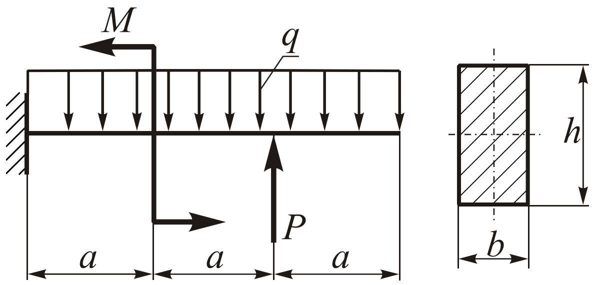
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 34

1. Parallel transfer of axes of inertia (proof). Calculation of axial moments of inertia relative to axes which are parallel to original central ones.
2. Factors (characteristics) of material strength. Method of determination of allowable stresses.

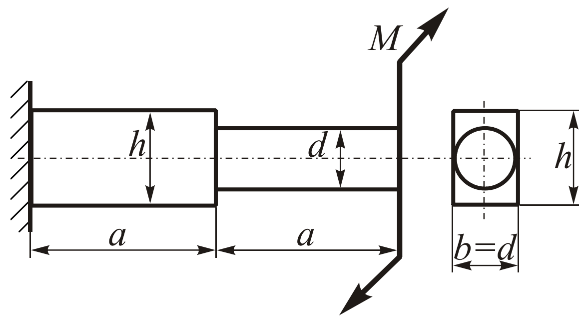
3.



Given: *a=3 m, q=2 kN/m, P=10kN, M=6 kNm,* $[\sigma]=100$ *MPa, h/b=2.*

Aim: determine dimensions of rectangle cross-section and also draw graphs σ_x and τ_{xz} distribution in critical section.

4.



Given: $h=2b$, $b=d=4\times10^{-2}$ *m,* $[\tau]=80$ *MPa.*

Aim: determine allowable external torsional moment *[M]* .

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

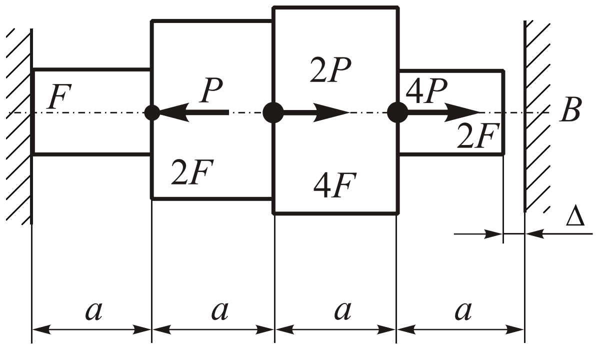
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 35

1. Rotation of axes of inertia. Proof of the formula of product of inertia in rotation of axes. Determination of principal axes position and calculation of principal moments of inertia.
2. Relationships between internal forces and internal stresses in cross-section for simple deformations.

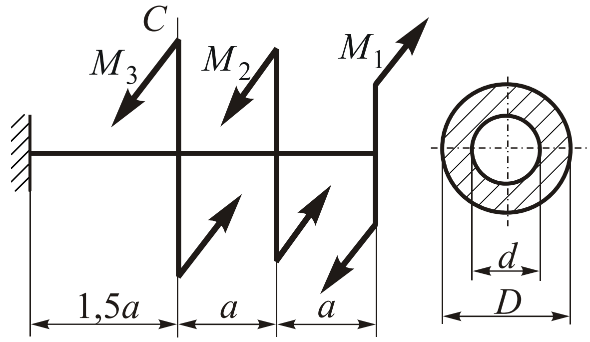
3.



Given: *a=1 m, Δ=0.3 mm, A=10cm*^{2}*, P=60kN.*

Aim: determine stresses in cross-sections of the rod

4.



Given: $a=0.5$ m, $\alpha=d/D=0.8$, $G=8\times10^4$ MPa, $[\theta]=1$ degree/m, $M_1=40$ kNm, $M_2=8$ kNm, $M_3=10$ kNm.

Aim: calculate ***d*** and ***D*** of the shaft and also angle of twist of ***C***-section.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

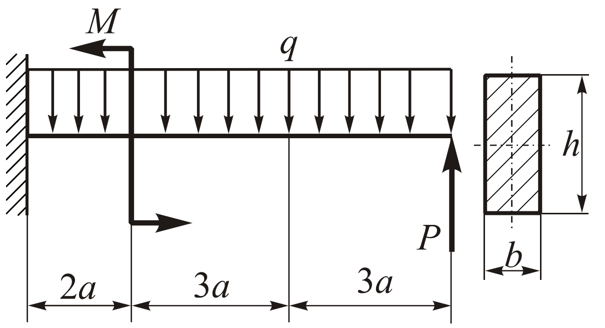
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 36

1. Plane stress state at a point of deformable solid. Proof of the formulae for calculation of stresses in the plane of general position in plane stress state.
2. Properties of material ductility in tension test.

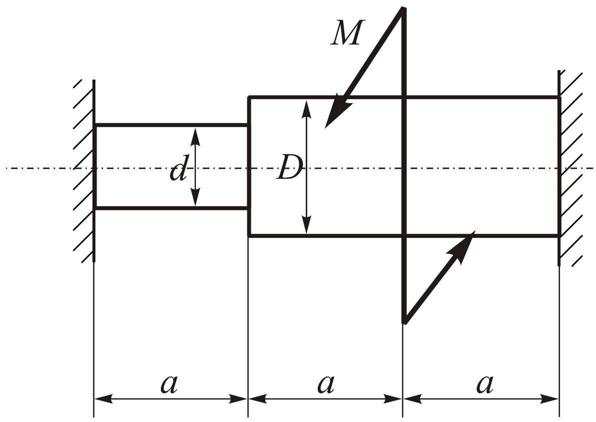
3.



Given: *a=1 m, q=2 kN/m, P=6 kN, M=4 kNm,* $[\sigma]$*=200 MPa.*

Aim: determine *h* .

4.



Given: $D=8\times10^{-2}$ m, $d=4\times10^{-2}$ m, *a=1 m,* $G=0.8\times10^{11}$ Pa, *M=10 kNm,* $[\tau]$*=80 MPa.*

Aim: check the strength of the shaft.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

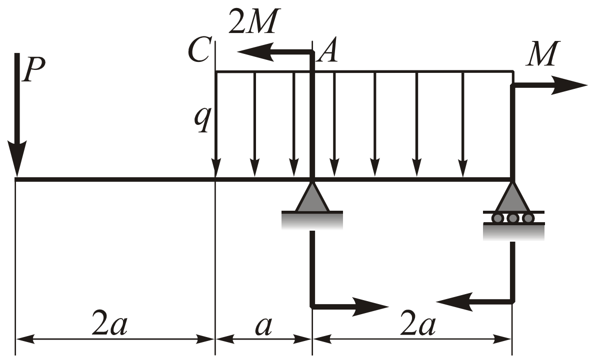
Degree B. Sc.   Branch of education: 1001   **Aerospace Engineering**   Semester **III**

Course **“Mechanics of materials”**

Examination card № 37

1. Stresses at the plane of general position in plane stress state. Proof of the formula for principal stresses and positions of principal planes.
2. Principle of superposition.

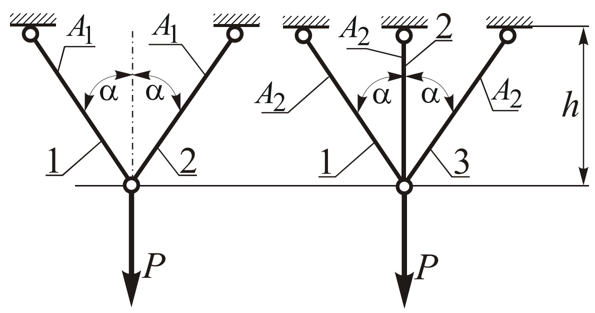
3.



Given: *a=1 m, q=2 kN/m, P=12 kN, M=6 kNm,* $[\sigma]$*=200 MPa. h/b=2*

Aim: determine dimensions of rectangle cross section and calculate τ_{max} in *C*-section.

4.



Given: *h=1 m, P=20kN,* $\alpha=30°$, $[\sigma]$*=160 MPa,* $\rho=7.8\times10^3$ *kg/m*^{3}.

Aim: determine areas A_1, A_2 for two rod systems and compare their masses.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

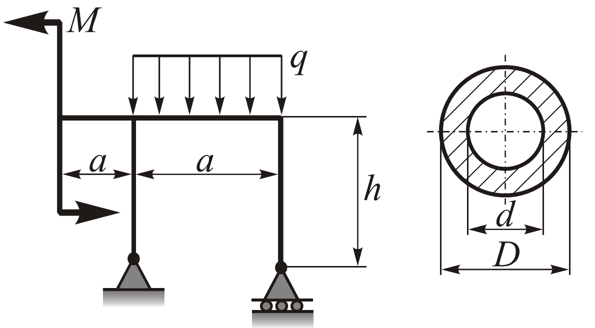
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 38

1. Mohr's circle in solution of direct and inverse problems of plane stress state (essence of the method and examples of solution).
2. External and internal forces, their types and units.

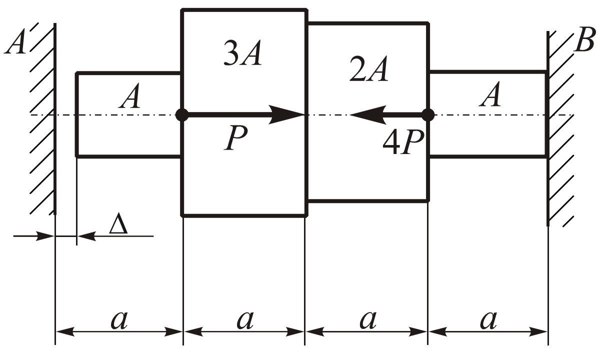
3.



Given: *a=1 m, h=2 m, q=2 kN/m, M=8 kNm,* *[σ]=100 MPa, d/D=0,8.*

Aim: draw graphs N_x, Q_z, M_y; calculate *D*.

4.



Given: *a=1 m, P=60 kN,* $A=10cm^2$, $\Delta=0.2$ *mm,* $E=2\times10^5$ *MPa,*

Aim: draw graphs $N_x(x)$ and $\sigma_x(x)$.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

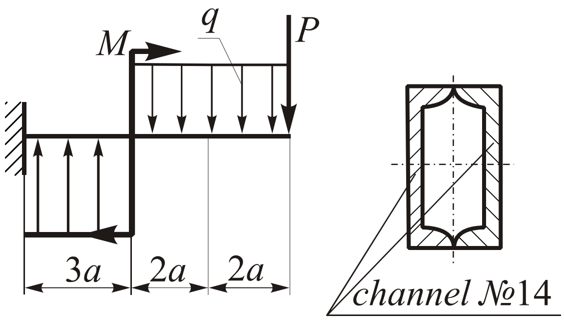
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 39

1. Proof of generalized Hooke's law equations.
2. Principles of rational orientation of specified cross-section in plane bending.

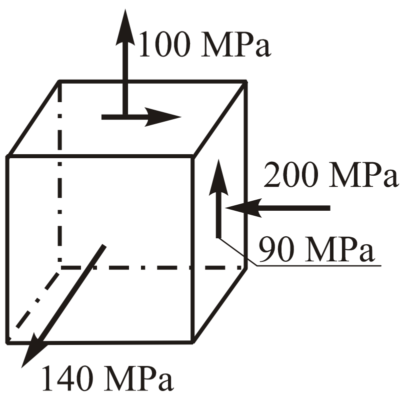
3.



Given: a=2 m, $P=2qa$, $M=4qa^2$, $[\sigma]$=200 MPa.

Aim: determine ***[q]***.

4.



Given: $E=2\times10^5$ MPa, $\mu=0.3$.

Aim: determine position of principal planes and principal stresses and also relative change in volume ε_v.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

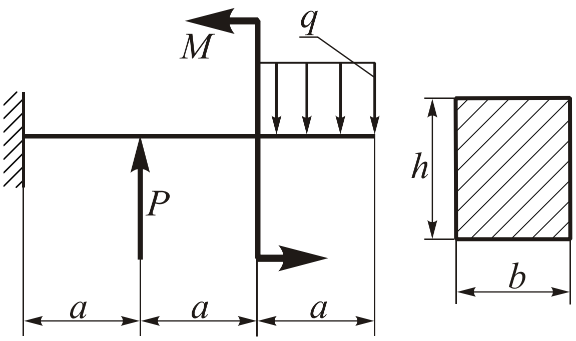
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 40

1. Strain state at a point of elastic deformable solid. Relationships between displacements and components of strain state (Cauchy equations).
2. Sectional moduli of cross-sections (definition and examples of determination for simple cross-sections).

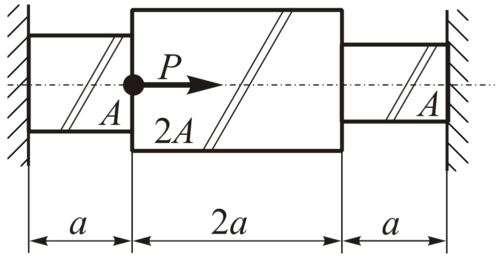
3.



Given: *a=1 m, M=30 kNm, q=40 kN/m, P=20 kN, b=5×10^{-2} m, h=10×10^{-2}m, [σ]=100 MPa.*

Aim: calculate σ_{max} and check the strength of the beam.

4.



Given: *a=1 m, P=80 kN, $[\sigma]_t$=160 MPa, $[\sigma]_c$=100 MPa, A=10cm^{2}, E=2×10^{11} Pa, α_t =17.5×10^{-6} 1/K, Δt =50 °K*

Aim: check the strength of the rod.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

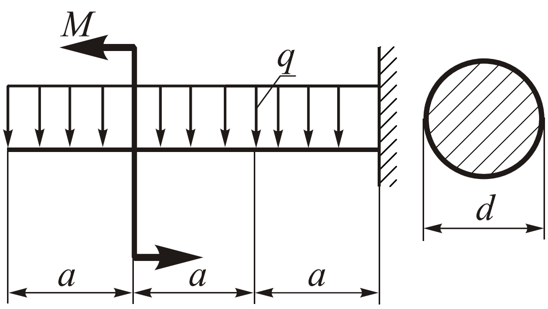
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 41

1. Tension-compression of prismatic rod. Hypothesis of plane sections. Normal stresses and condition of strength.
2. Axial and polar moments of inertia and also product of inertia: definitions and relationships between axial and polar moments of inertia.

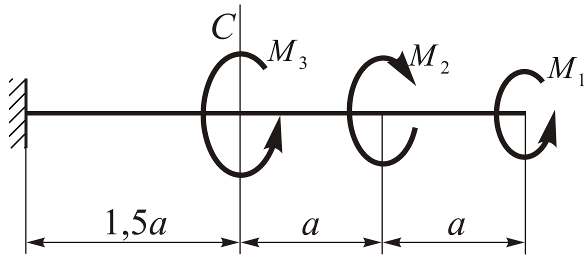
3.



Given: $a=1$ m, $d=8\times10^{-2}$ m, $[\sigma]=180$ MPa, $M=4qa^2$

Aim: draw graphs Q_z, M_y and determine allowable value of intensity of external load $[q]$.

4.



Given: $G=8\times10^4$ MPa, $[\psi]=1$ degree/m, $a=1.0$ m, $d/D=0.8$, $M_1=20$ kNm, $M_2=15$ kNm, $M_3=8$ kNm,

Aim: draw graph $M_x(x)$, determine diameters of hollow shaft and also angle of twist in C-section.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

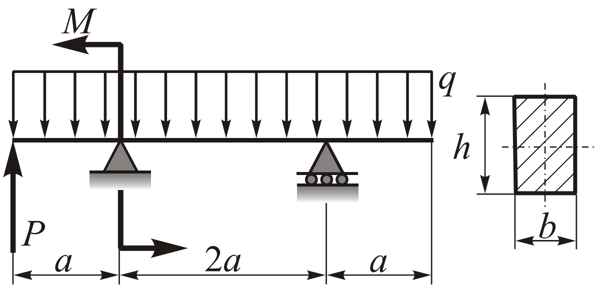
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 42

1. Tension-compression of prismatic rod. Calculation of strains and displacements. Condition of rigidity.
2. Principal axes of inertia. Properties (extremity) of geometrical characteristics of the cross-section relative to principal axes.

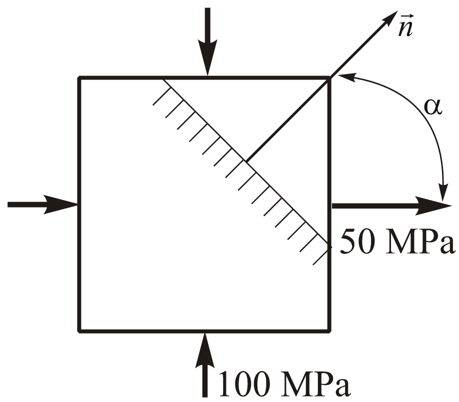
3.



Given: *a=2 m, M=20 kNm, P=30 kN, h/b=2, [σ]=200 MPa.*

Aim: determine *h, b.*

4.



Given: $E=2\times10^5$ *MPa,* $\mu=0.3$, $\alpha=45°$.

Aim: determine acting stresses at inclined plane and also relative change in volume ε_v.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

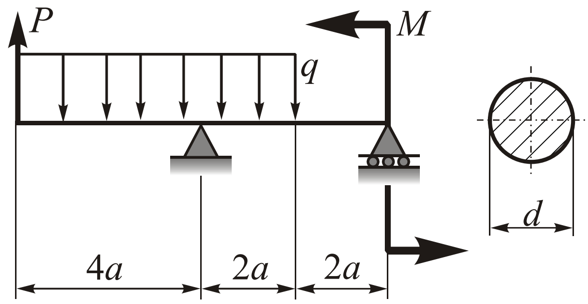
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 43

1. Statically indeterminate rod systems in tension-compression (examples of the opening of statical indeterminacy).
2. Method of sections as the principle of determination of internal forces.

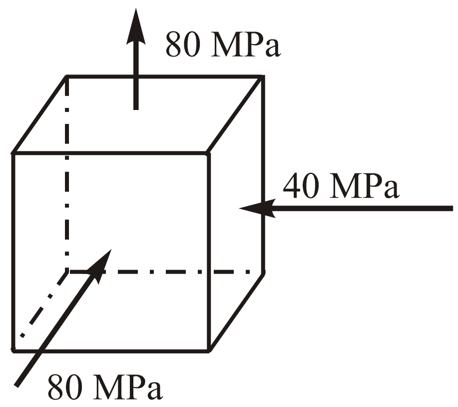
3.



Given: *a=1 m, M=60kNm, P=80 kN, q=10 kN/m* *[σ]=140 MPa.*

Aim: determine *d*.

4.



Given: μ=0,28, $E = 2 \cdot 10^{11}$ *Pa.*

Aim: determine deformations of element's edges and relative change of its volume.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

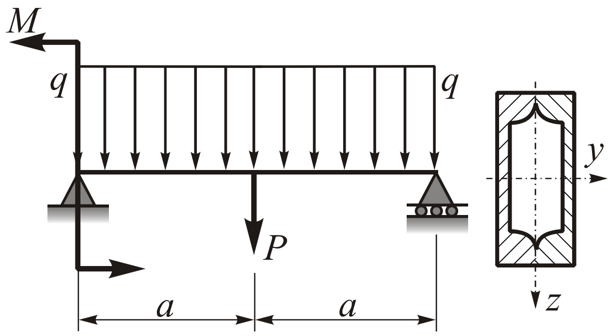
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 44

1. Thermal stresses in statically indeterminate rod systems in tension-compression (illustration of the method of internal forces calculation in example).
2. Allowable stress and its determination for ductile and brittle materials.

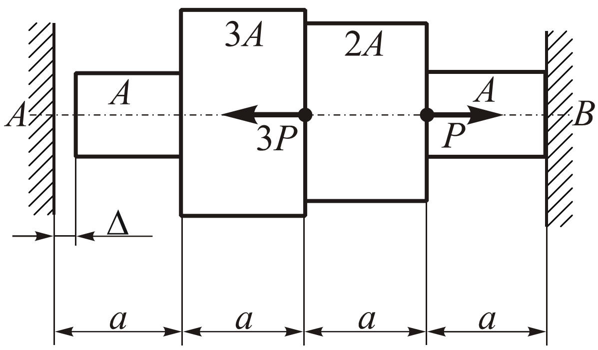
3.



Given: $a=3$ m, $M=20$ kNm, $q=40$ kN/m, $P=10$kN, $[\sigma]_c=200$ MPa, . $[\sigma]_t=160$ MPa

Aim: determine number of the channel in box composite section

4.



Given: $a=1$ m, $\Delta=0.1\times10^{-2}$ m, $A=10\times10^{-4}$ m^2, $P=40$ kN, $[\sigma]=200$ MPa .

Aim: determine stresses and check the strength.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

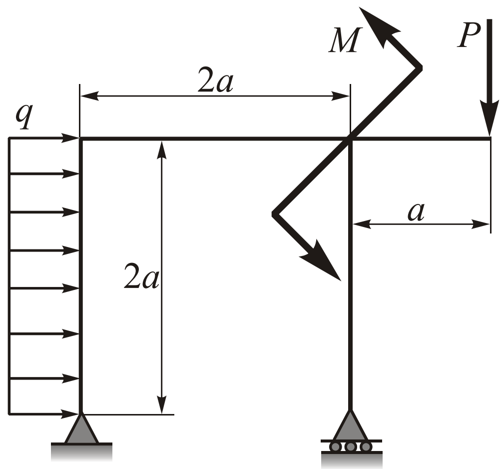
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 45

1. Torsional deformation. Proof of the torsional formula for stresses in round and hollow shafts. General assumptions. Geometrical presentation of stress distribution.
2. Essence of method of sections and general goal of its application in mechanics of materials.

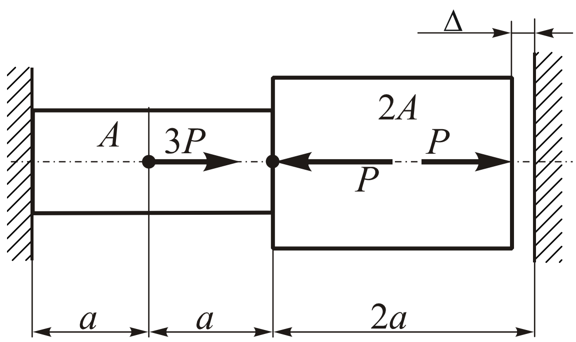
3.



Given: *a=2 m, P=6 kN, M=10 kNm, q=10 kN/m*

Aim: draw graphs N_x, Q_z, M_y;

4.



Given: Δ=0.1 mm, *a*=1 m, *P*=20 kN, $A=20\times10^{-4}$ m^2, $[\sigma]$=200 MPa, $E=2\times10^5$ MPa.

Aim: determine acting stresses and check the strength.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

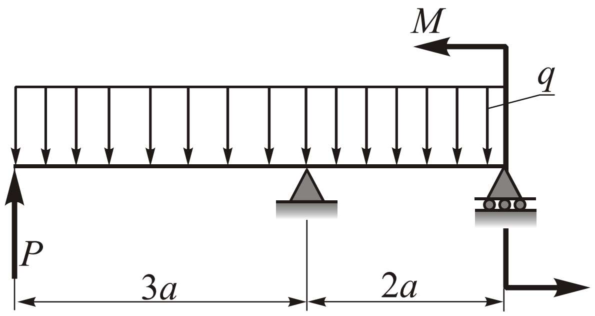
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 46

1. Torsional deformation. Formula for the angle of twist for round and hollow shafts (proof). Condition of rigidity.
2. Hooke's law in tension-compression and pure shear.

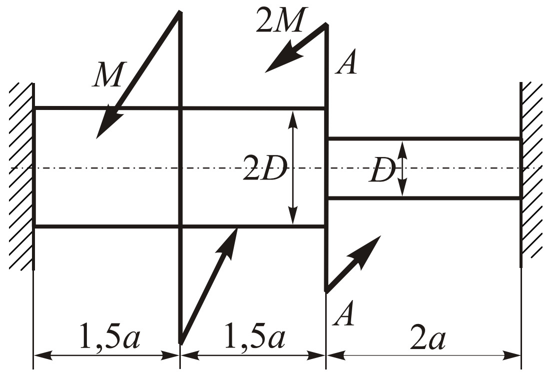
3.



Given: a=2 m, $M=2qa^2$, $[\sigma]$=100 MPa, I №10 .

Aim: calculate allowable value of external loading $[q]$.

4.



Given: $D=8\times10^{-2}$ m, a=1 m, $G=0.8\times10^{11}$ Pa, M=10 kNm, $[\tau]$=80 MPa.

Aim: check the strength of the shaft.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

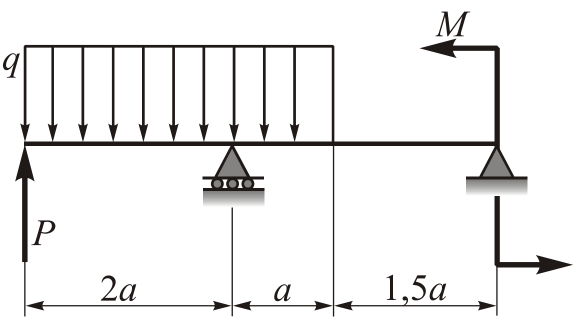
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 47

1. Torsion of the shaft with rectangle cross-section. Formula for maximum shear stresses. Position of critical points and condition of strength.
2. "Load-displacement" and "stress-strain" diagrams in tension of ductile material. Mechanical properties, which are calculated from "stress-strain" diagram. Conventional yield limit.

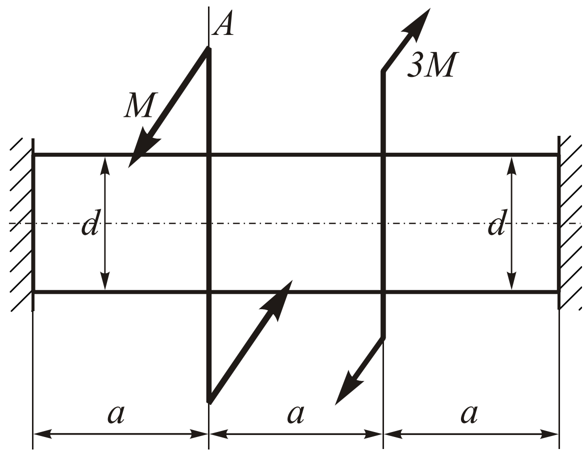
3.



Given: *a=2 m, M=30 kNm, P=10 kN, q=2 kN/m, [σ]=180 MPa,*

Aim: determine the number of I-beam section and calculate $\tau_{\max}$.

4.



Given: *a=2 m, d=8 cm, [τ]=80 MPa*

Aim: calculate allowable value of external moment [*M*].

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

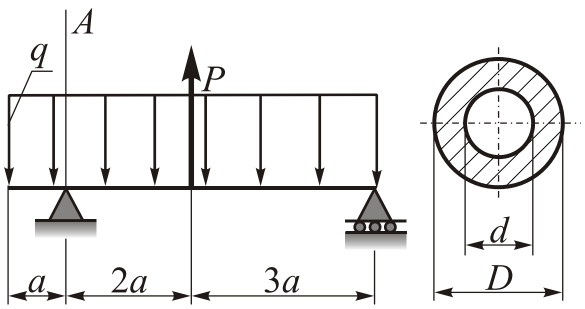
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 48

1. Torsional deformation of the shafts with rectangle cross-section. Formula for angle of twist and condition of rigidity.
2. Characteristics of material strength. Method of calculation of allowable stresses.

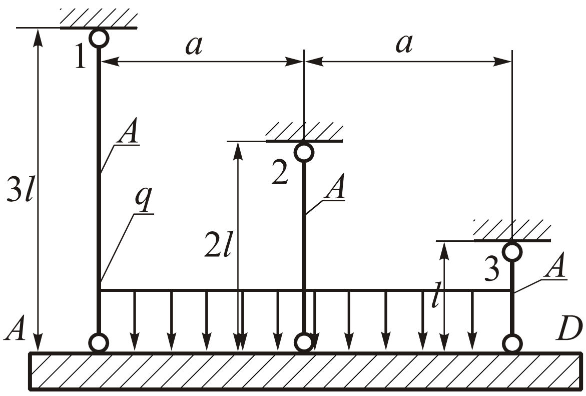
3.



Given: *a=1 m, P=40 kN, q=20 kN/m, d/D=0.8,* $[\sigma]$*=100 MPa.*

Aim: calcilate *D*; draw the graph $\sigma_x(z)$ in critical cross-section.

4.



Given: $a=2$ m, $q=10$ kN/m, $E=2\times10^5$ MPa, $[\sigma]=140$ MPa, $A_1=A_2=A_3=A$, *AD – absolutely rigid beam.*

Aim: 1. Determine internal forces in the rods *1, 2, 3*;
2. Determine cross-sectional area *A*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

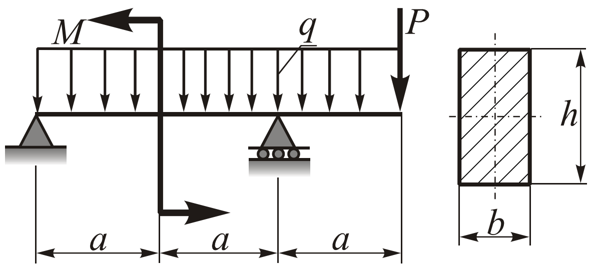
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 49

1. Torsional deformation of solid round shafts. Torsional formula (proof). Condition of strength.
2. Generalized Hooke’s law and its application for calculation of the relative change of elastic material volume.

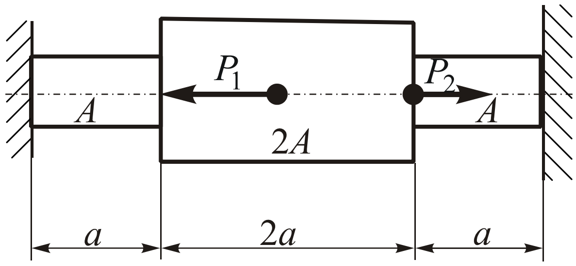
3.



Given: a=1 m, M=30 kNM, q=20 kN/m, P=20 kN, h =10 cm, b=5 cm, $[\sigma]$=200 MPa.

Aim: check the strength, calculate τ_{max}.

4.



Given: a=1 m, P_1=30 kN, P_2=10 kN, $[\sigma]$=160 MPa, $A=20cm^2$.

Aim: determine internal force N_x, calculate acting stresses σ_x, F. check the strength of a rod.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

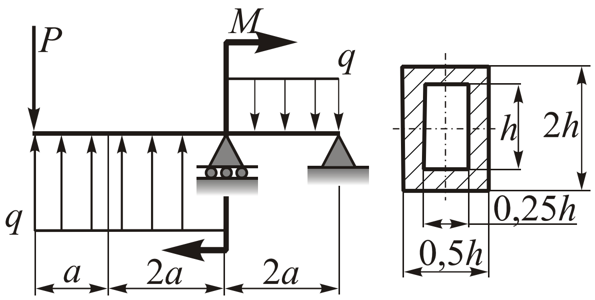
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 50

1. Method of opening of statical indeterminacy of shafts (describe an example).
2. Concepts of principal planes stresses and principal strains. Types of stress state at a point of deformable solid.

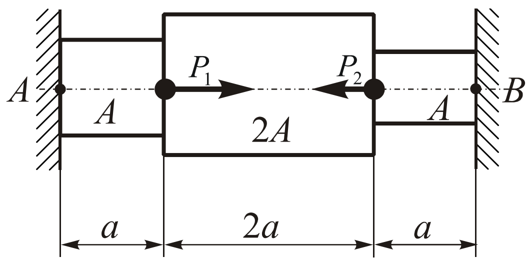
3.



Given: *a=1 m, M=40 kNm, P=10 kN, q=20 kN/m, [σ]=200 MPa.*

Aim: calculate *h*.

4.



Given: $A=10\times10^{-4}$ m^2, *a=1 m*, $P_1=20$ *kN*, $P_2=50$ *kN*, $E=2\times10^{11}$ *Pa.*

Aim: calculate stresses in the rod.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

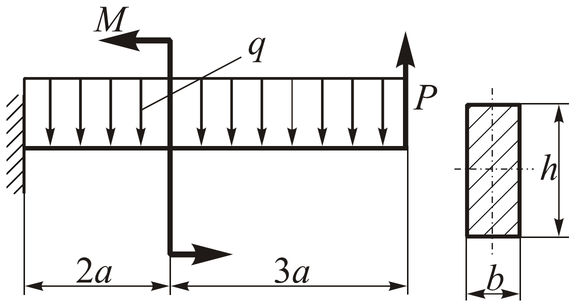
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 51

1. Types of bending. Bending formula for normal stresses in cross-section of prismatic bar in pure bending (proof). Condition of strength, types of engineering problems which are solved using condition of strength.
2. General hypotheses in mechanics of materials.

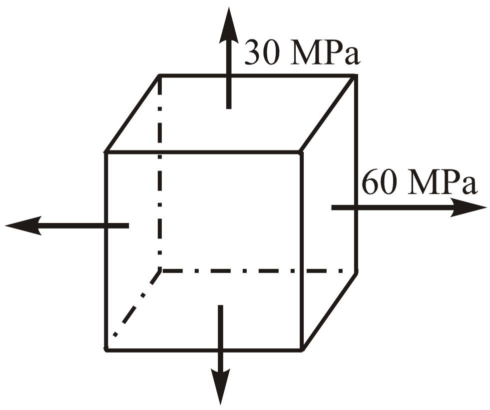
3.



Given: $a=1$ m, $h=2b$, $P=40$ kN, $M=30$ kNm, $q=20$ kN/m, $[\sigma]=160$ MPa.

Aim: calculate b, h

4.



Given: $E=2\times10^{11}$ Pa, $\mu=0.3$

Aim: calculate strains of the element edges and relative change in volume.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

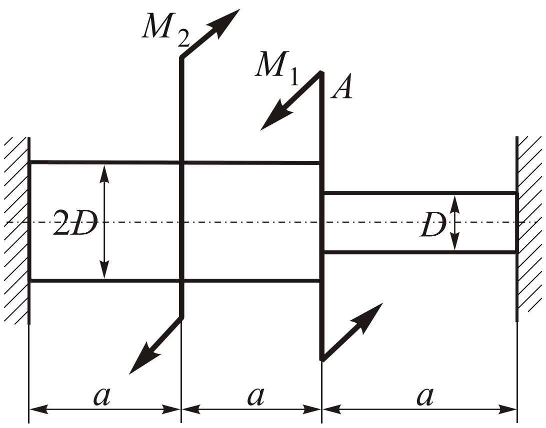
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 52

1. Transverse bending of prismatic bar. Proof of Juravsky formula for shear stresses in transverse bending. The graphs of shear stress distribution in round, rectangle and I-beam sections.
2. Elastic moduli and their correlation.

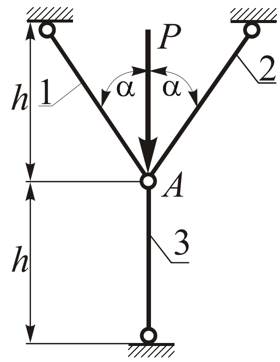
3.



Given: $a=1$ m, $M_1=10$ kNm, $M_2=40$ kNm, $[\tau]=80$ MPa, $G=0.8\times10^{11}$ Pa.

Aim: calculate diameter D.

4.



Given: $b=100$ cm, $\delta=0.02\times10^{-2}$ m, $A_1=A_2=A_3=2\times10^{-4}$ m^2, $E_1=E_2=E_3=2\times10^5$ MPa, $\varphi=30°$.

Aim: calculate stresses in the rods after assembly.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

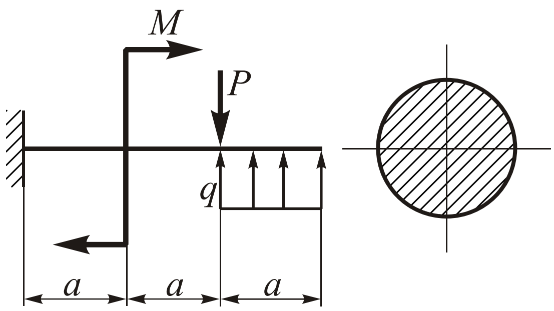
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 53

1. Differential relationships between $q(x)$, $Q_z(x), M_y(x)$ in plane bending (proof) and their application for checking the accuracy of internal force diagrams.
2. Hypothesis of plane sections and its application in proof of bending formula.

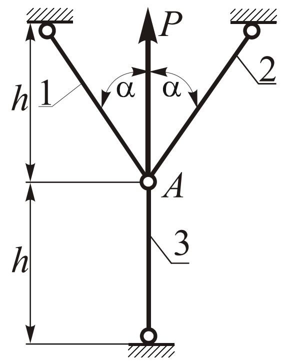
3.



Given: $a=1$ m, $M=60$ kNm, $q=20$ kN/m, $p=10$ kN, $[\sigma]=200$ MPa.

Aim: calculate the diameter of the beam.

4.



Given: $h=1$ m, $A_1=A_2=A$, $A_3=2A$, $\alpha=30°$, $[\sigma]=160$ MPa, $P=40$ kN, $E_1=E_2=E_3=E=2\times10^5$ MPa .

Aim: calculate cross-sectional area A.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

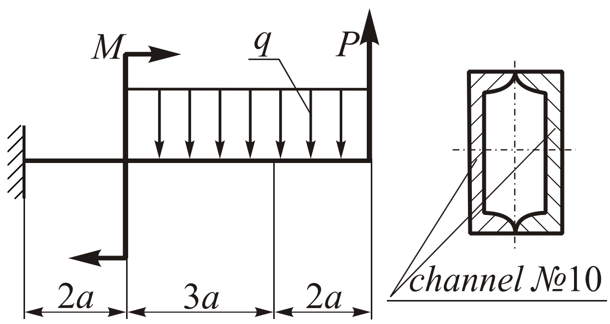
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 54

1. Proof of the differential equation of deflection curve. Calculation of the constants of integration.
2. Poisson’s ratio and the method of its experimental determination.

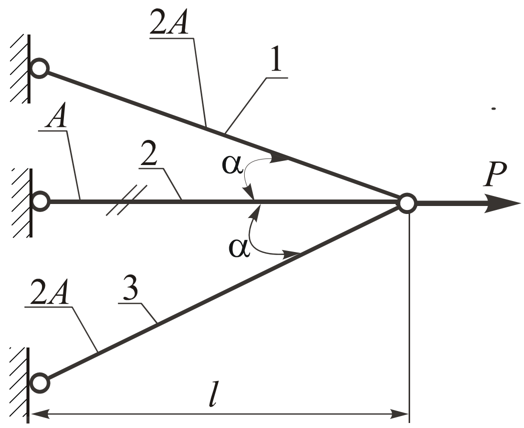
3.



Given: *a=1 m, M=20 kNm, q=10 kN/m, P=10kN, composite cross-section consisting of two channels №10,* $[\sigma]=160$ *MPa.*

Aim: check the strength of the cantilever beam and find the largest shear stresses.

4.



Given: central rod 2 is heated at 60 K, P=10 kN, $\alpha_t=1.25\times10^{-5}$ 1/K, $E=2\times10^{5}$ MPa, $A=5\times10^{-4}$ m^2, $l=2$ m, $\alpha=30°$, $[\sigma]=160$ MPa.

Aim: check the strength of the rods.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

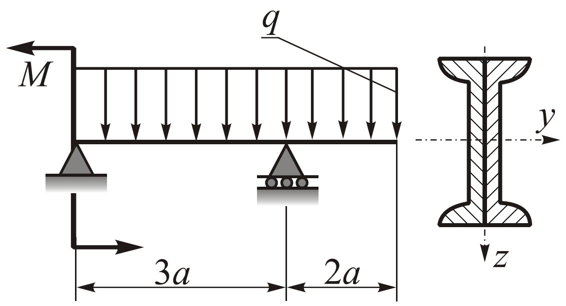
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 55

1. Proof of generalized Hooke’s law equations.
2. Geometrical and physical sense of elasticity modulus. Method of its experimental study.

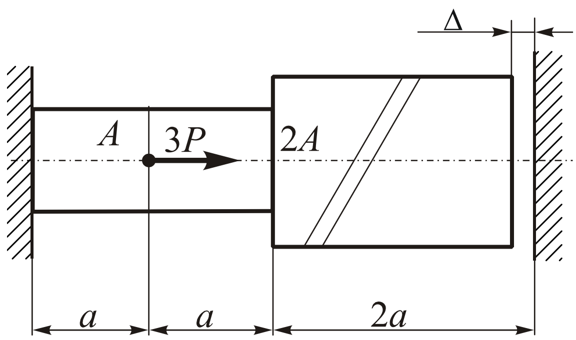
3.



Given: $a=1$ m, $q=10$ kN/m, $M=12$ kNm, $[\sigma]=180$ MPa.

Aim: draw the graphs of $Q_z(x)$, $M_y(x)$; determine the number of channel section as the half of composite section; calculate $\sigma_{\max}$ and $\tau_{\max}$.

4.



Given: $a=1$ m, $A=10\times10^{-4}$ m^2, $[\sigma]=200$ MPa, $\alpha=1.75\times10^{-5}$ 1/K, $E=2\times10^{11}$ Pa, $\Delta=0.2$ mm, $P=40$ kN, $\Delta t=50$ °K.

Aim: check the strength of the rod.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

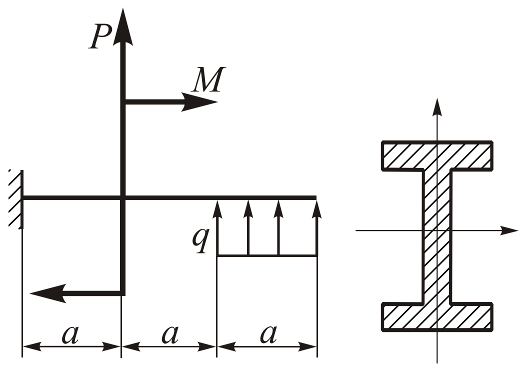
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 56

1. Torsional deformation of solid round and hollow shafts. Formula for angle of twist (proof). Condition of rigidity.
2. Generalized Hooke's law and its application for calculation of stresses, strains and relative change of elastic material volume (unit volume change).

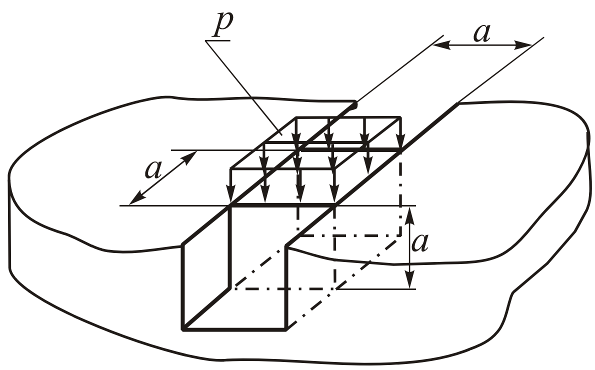
3.



Given: *a=1 m, q=20 kN/m, P=10 kN, M=60 kNm,* $[\sigma]$*=200 MPa.*

Aim: determine the number of I-beam section.

4.



Given: $a=10\times10^{-3}$ *m,* *P=60 MPa,* $E=2\times10^{5}$ *MPa,* $\mu=0.30$.

Aim: calculate: a) stresses on the faces of the element; b) strains of its ages; c) relative change of element volume.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

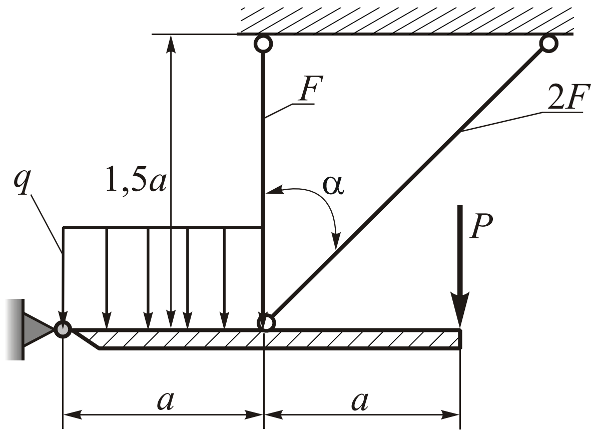
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 57

1. Shear stresses in transverse bending. Proof of the Juravsky formula. Graphs of shear stress distribution for round solid, round hollow and rectangle cross-section.
2. Tension test of material, mechanical properties as the results of the test, allowable stresses.

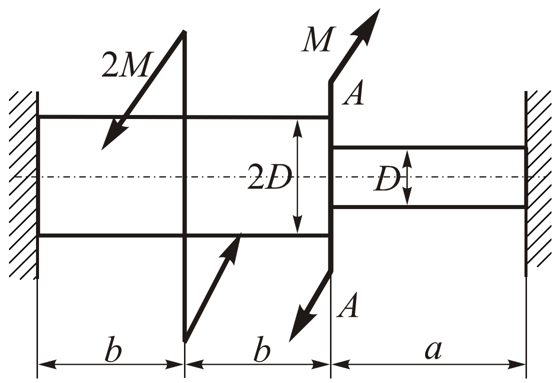
3.



Given: *a=1 m, P=10 kN, q=20 kN/m,* *[σ]=200 MPa,* $A=10\ cm^2$, *α =30°K*

Aim: calculate cross-sectional area *A*.

4.



Given: *a=2 m, b=1.2 m, M=30 kNm,* $G=8\times10^4$ *MPa, [ψ]=0.5 degree/m.*

Aim: calculate *D* and angle of twist of *A* cross-section.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

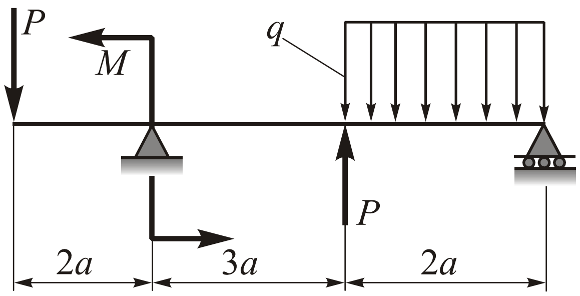
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 58

1. Formula for calculation of normal stresses at an arbitrary point of the beam in transverse bending (proof). Maximum bending stresses, condition of strength.
2. First moment of area. Central axes. Method of calculation of cross-sectional centroid (an example).

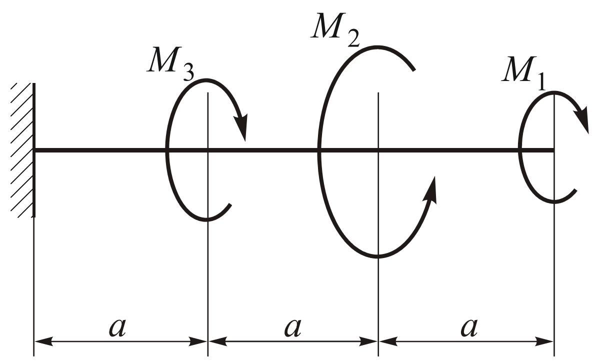
3.



Given: *a=0.5 m, P=20 kN, M=40 kNm, q=20 kN/m,* $[\sigma]$*=200 MPa.*

Aim: determine the dimensions of I-beam section (number) and draw the graph of σ_x distribution in *C* –section.

4.



Given: *a=1 m,* M_1*=20 kNm,* M_2*=50 kNm,* M_3*=10 kNm,* $[\tau]$*=100 MPa,* $G=8\times10^4$ *MPa,* $[\psi]$*=0.5 degree/m.*

Aim: calculate the diameter of solid shaft.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

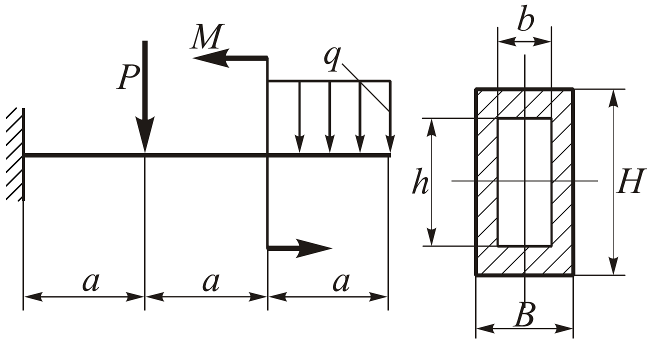
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 59

1. Differential relationships between $q(x)$, $Q_z(x), M_y(x)$ in plane bending (proof) and their application for checking the graphs of internal forces distribution (an example).
2. Methods of experimental study of strain state of elastically deformable solid.

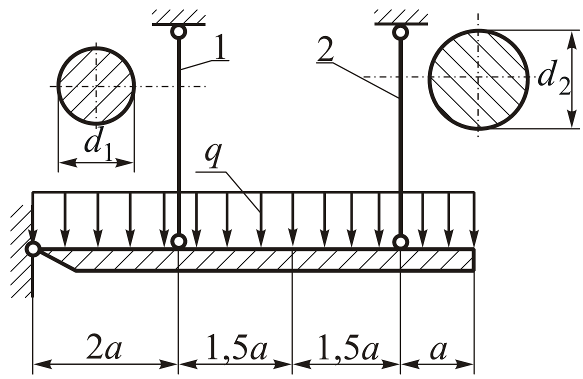
3.



Given: $a=1$ m, $M=2qa^2$, $H=8\times10^{-2}$ m, $h=6\times10^{-2}$ m, $B=6\times10^{-2}$ m, $b=4\times10^{-2}$ m, $[\sigma]=100$ MPa.

Aim: calculate $[q]$.

4.



Given: $a=1$ m, $d_1/d_2=0.8$, $q=40$ kN/m, $[\sigma]=160$ MPa.

Aim: calculate d_1, d_2.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

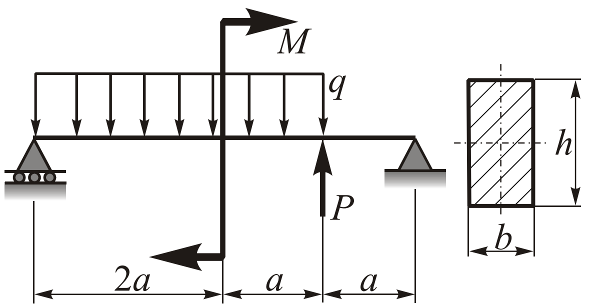
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 60

1. Experimental study of mechanical properties of structural materials. Description of the method and test device. Properties of material strength and ductility.
2. Method of the opening of static indeterminacy of the rod systems (consider an example and describe general procedures).

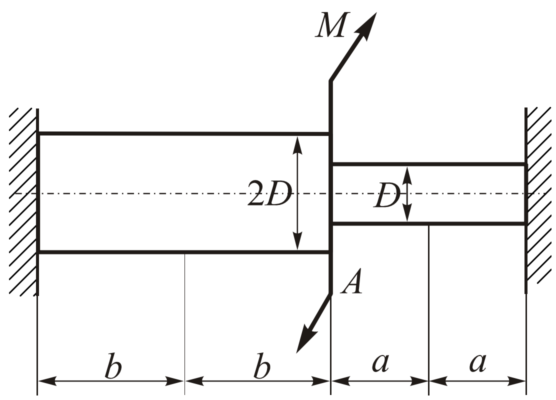
3.



Given: $a=1.0$ m, $M=10$ kNm, $q=20$ kN/m, $b=5\times10^{-2}$ m, $h/b=2$, $[\sigma]=200$ MPa.

Aim: check the strength of the beam and draw the graphs $\sigma_x(z)$ and $\tau_{xz}(z)$ in corresponding critical cross-sections.

4.



Given: $a=0.8$ m, $b=1.2$ m, $M=30$ kNm, $[\tau]=70$ MPa, $G=8\times10^{4}$ MPa.

Aim: calculate D and the angle of twist of A-section.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

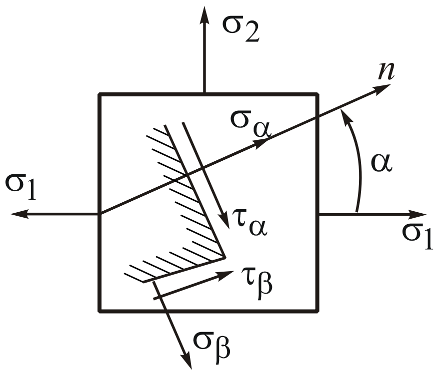
Degree B. Sc.   Branch of education: 1001   **Aerospace Engineering**   Semester **III**

Course **"Mechanics of materials"**

Examination card № 61

1. Transverse bending of prismatic bar. Proof of Juravsky formula for shear stresses in transverse bending. The graphs of shear stress distribution in round, rectangle and I-beam sections.
2. Compare the "load-displacement" and "stress-strain" diagrams for ductile material.

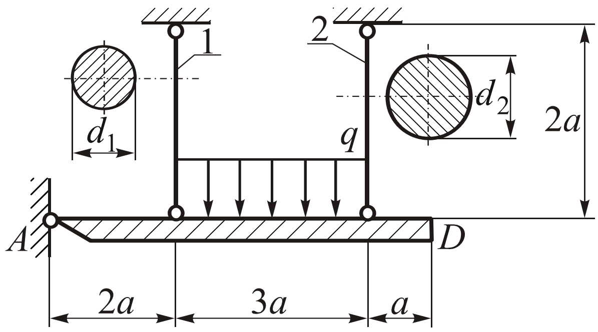
3.



Given: σ_1 =*100MPa,* σ_2 =*60MPa,* α =*30°*

Aim: calculate $\sigma_\alpha, \sigma_\beta, \tau_\alpha, \tau_\beta$.

4.



Given: *a=1.0 m,* $d_1=4\times10^{-2}$ *m,* $d_2=6\times10^{-2}$ *m,* *[τ]=160 MPa, AD – absolutely rigid beam.*

Aim: calculate *[q]*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,**   21 November**,** 2011

Head of Department, Doctor of Science, Professor   **Fomichov P.O.**

Examiner   **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

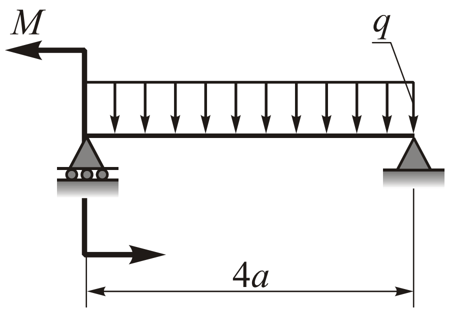
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 62

1. Method of opening of static indeterminacy of the shafts in torsion (use the example).
2. Allowable stress and the method of its determination. Correlation between *[τ]* and *[σ]*.

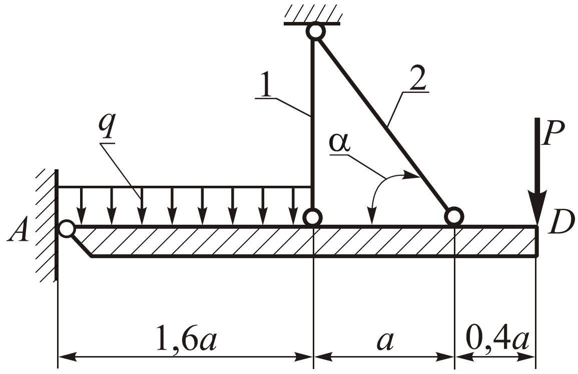
3.



Given: *a=1 m, M=40kN/m, q=20kN/m, [σ]=160 MPa,*
Cross-section – I-beam № 20.

Aim: check the strength.

4.



Given: *a=1 m, P=100 kN, q = 20kN/m, $d_1 = d_2 = d$, α=60°, cross-section – round, [σ]=160 MPa , AD – absolutely rigid beam.*

Aim: calculate *d*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

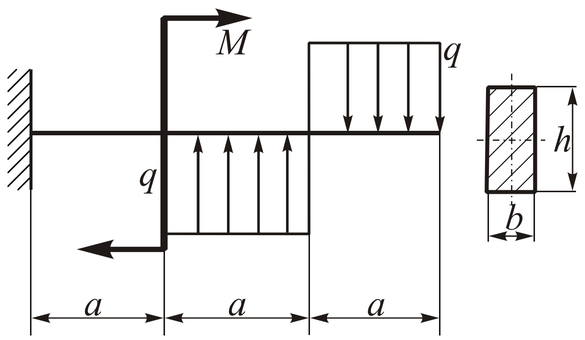
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 63

1. Types of bending. Bending formula for prismatic beam in pure plane bending (proof). Condition of strength. Stress distribution in round cross-section.
2. Poisson's ration and its determination.

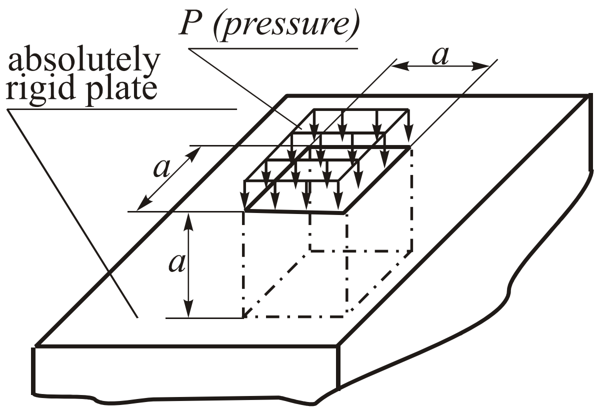
3.



Given: $a=1$ m, $M=40$ kNm, $[\sigma]=200$ MPa, $q=20$ kN/m, $h/b=2$.

Aim: calculate *h, b*, draw the graph of $\sigma_x(z)$ in critical section.

4.



Given: $a=0.1\times10^{-2}$ m, $P=100$ MPa, $\mu=0.28$, $E=2\times10^{5}$ MPa.

Aim: calculate stresses on the faces of absolutely elastic element and its relative change in volume.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

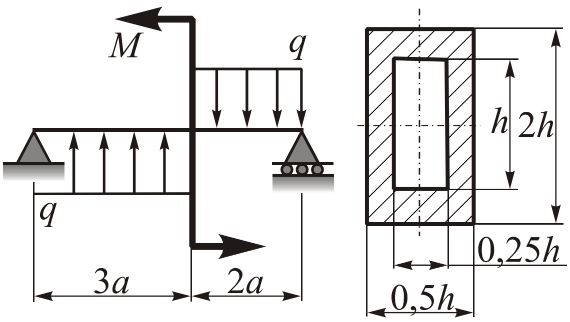
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 64

1. Torsion of the shafts with rectangle cross-section. Critical points, calculation of maximum stresses, condition of strength.
2. Axial moments of inertia. Formula for calculation central axial moments of inertia of round, rectangle and right triangle sections. Correlation between axial and polar moments of inertia.

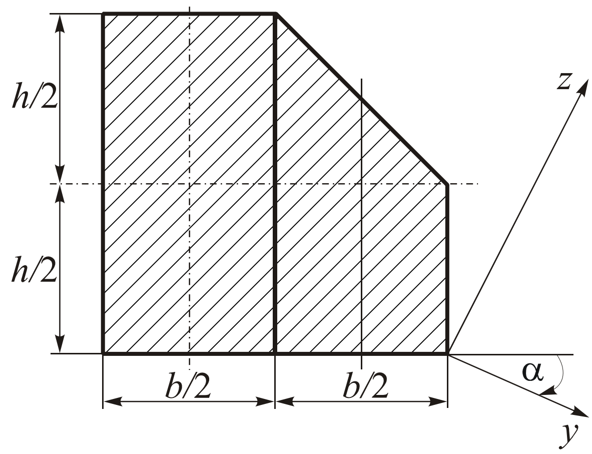
3.



Given: $a=2$ m, $M=20$ kNm, $q=30$ kN/m, $[\sigma]=200$ MPa, $h=20$ cm.

Aim: check the strength of the beam.

4.



Given: $b=20\times10^{-2}$ m, $h=20\times10^{-2}$ m, $\alpha=30°$.

Aim: calculate axial moments of inertia and also product of inertia of composite cross-section relative to y, z axes.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

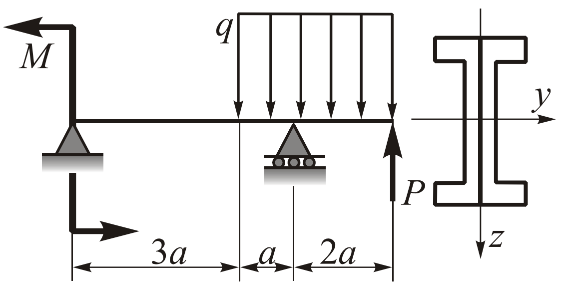
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 65

1. Transverse plane bending of prismatic beam. Proof of Juravsky formula for shear stress distribution over the cross-section.
2. Principal hypotheses and assumptions in mechanics of material

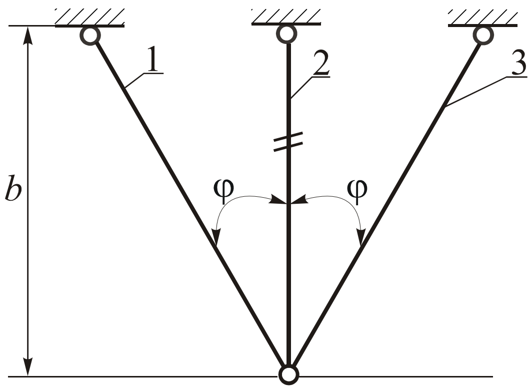
3.



__Given:__ *a=1 m, q=10 kN/m, M=20 kNm, P=10 kN,* *[σ]=180 MPa.*

__Aim:__ determine the number of channel section of composite beam.

4.



__Given:__ $b=2.0$ *м*, $\delta=0.2\times10^{-3}$ *m*,
$\Delta t = 50^\circ K$, $\alpha_t = 1.75\times10^{-5}\ 1/K$
$A_1=A_2=A_3=A=2\times10^{-4}$ $м^2$,
$E_1=E_2=E_3=E=2\times10^5$ *MPa*, $\varphi=30°$.

__Aim:__ calculate stresses in rods after assembly**.**

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

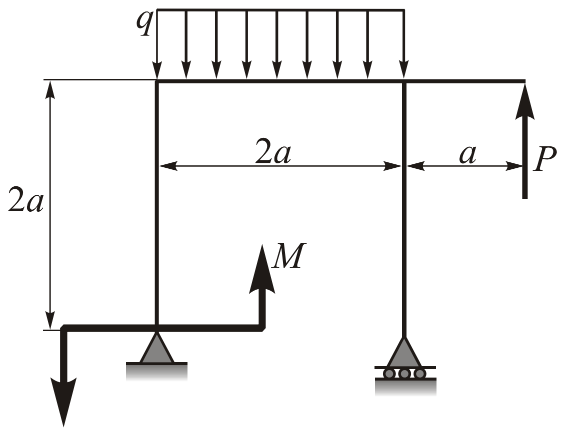
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 66

1. Differential relationships between $q(x)$, $Q_z(x), M_y(x)$ in plane bending (proof) and their application for checking the graphs of internal forces distribution (an example).
2. Hypothesis of plane sections and its use in proof of general formulae of tension-compression, torsion, bending.

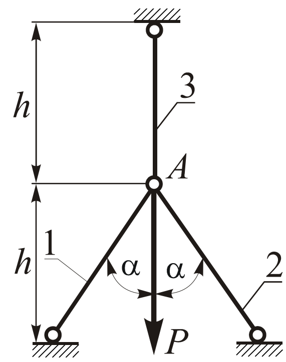
3.



Given: *a=0.5 m, M=6 kNm, q=18 kN/m, P=10 kN,* *[σ]=200 MPa.*

Aim: draw graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$; determine the diameter of round cross-section.

4.



Given: *h=1 м,* $A_1=A_2=A$, $A_3=2A$, $\alpha=30°$, $[\sigma]=140$ *MPa,* $P=40$ *kN,* $E_1=E_2=E_3=E=2\times10^5$ *MPa* .

Aim: determine cross-sectional area *A* and vertical displacement of the hinge *A*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

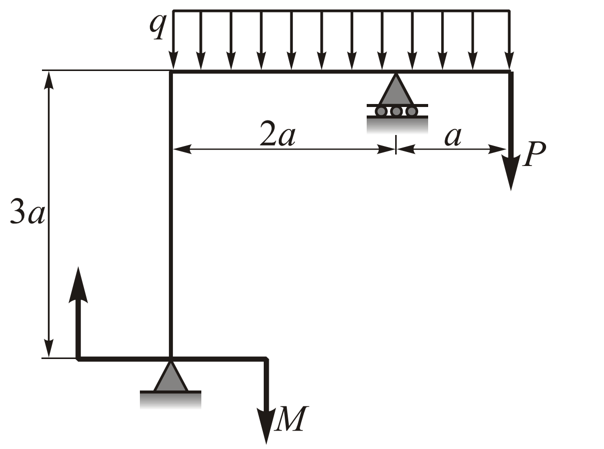
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 67

1. Generalized Hooke's law. Proof of its equations in terms of principal stresses.
2. Elastic moduli and their correlation

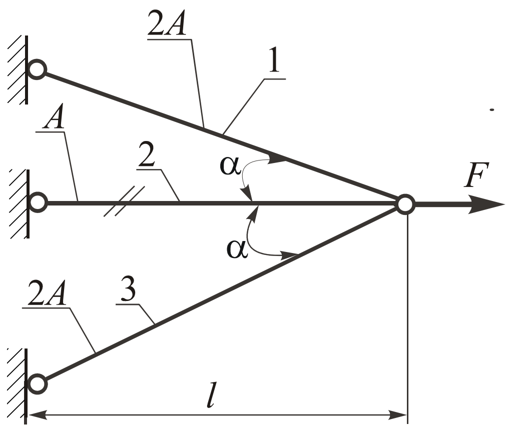
3.



Given: a=1 m, M=6 kNm, q=10 kN/m, P=10 kN, $[\sigma]$=160 MPa.

Aim: draw graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$; determine the diameter of the frame.

4.



Given: $E=2\times10^5$ MPa, F=60 kN, $A=2\times10^{-4}$ m^2, l=2 m, $\alpha=30°$, Δt =50°K, $\alpha_t=1.75\times10^{-5}$ 1/K

Aim: determine stresses in the rods *1*, *2*, *3*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

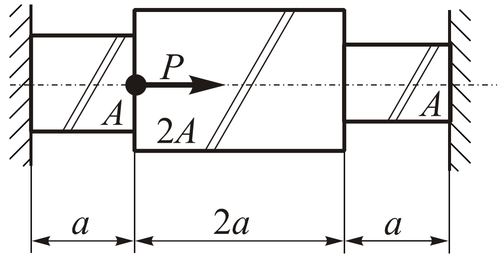
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 68

1. Proof of generalized Hooke’s law equations.
2. Sectional moduli of cross-sections (definition and examples of calculation for different cross-sections).

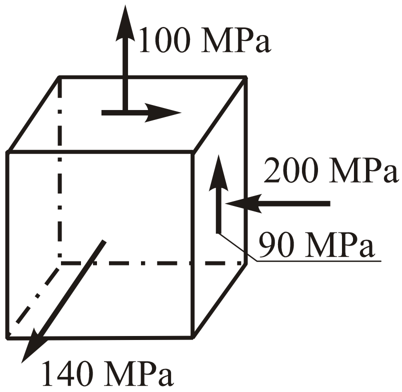
3.



Given: $a=1$ m, $P=80$ kN, $A=10cm^2$,
$E=2\times10^{11}$ Pa, $\alpha_t=17.5\times10^{-6}$ 1/K,
$\Delta t=40$ °K.

Aim: calculate stresses in the rod.

4.



Given: $E=2\times10^5$ MPa, $\mu=0.3$.

Aim: determine position of principal planes and principal stresses and also relative change in volume ε_v.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

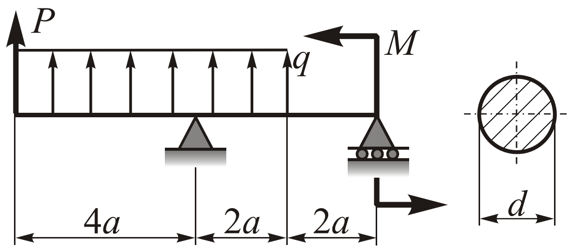
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **“Mechanics of materials”**

Examination card № 69

1. Proof of generalized Hooke’s law equations.
2. Method of sections as the principle of determination of internal forces.

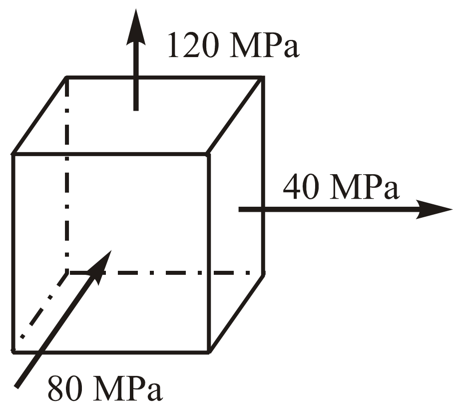
3.



Given: $a=1$ m, $d=0.08$ m, $M=2qa^2$, $P=2qa$, $[\sigma]=140$ MPa.

Aim: determine ***[q]***.

4.



Given: $\mu=0.28$, $E=2\cdot10^{11}$ Pa.

Aim: determine deformations of element’s edges and relative change of its volume.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

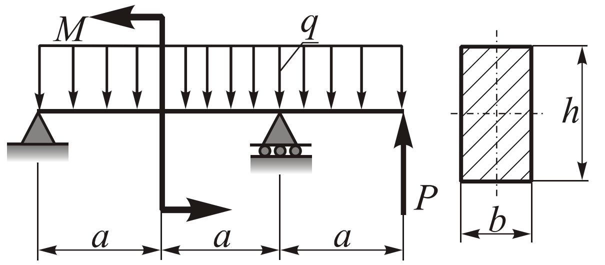
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 70

1. Torsional deformation of solid round shafts. Formula for angle of twist (proof). Condition of rigidity.
2. Generalized Hooke's law and its application for calculation of stresses, strains and relative change of elastic material volume.

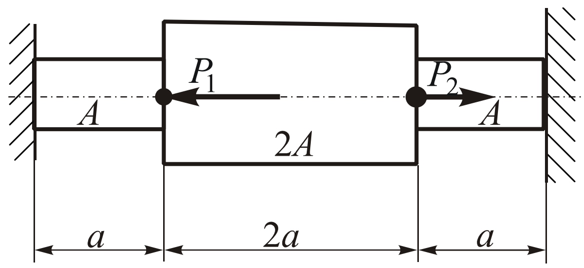
3.



Given: $a=1\ m$, $M=40\ kNM$, $q=20\ kN/m$, $P=10\ kN$, $h/b=2$, $[\sigma]=160\ MPa$.

Aim: calculate *b, h*.

4.



Given: $a=0.1\ m$, $P_1=40\ kN$, $P_2=10\ kN$, $[\sigma]=160\ MPa$.

Aim: determine internal forces N_x, calculate cross-sectional area A, determine acting stresses σ_x.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November, 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

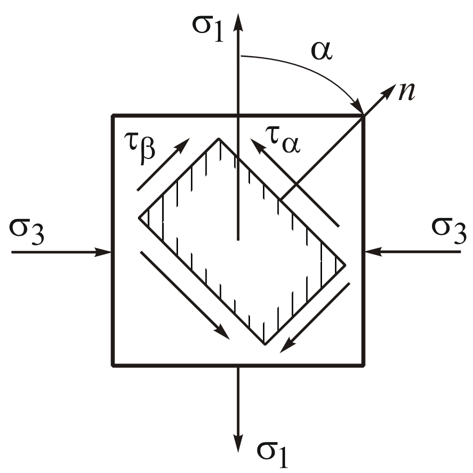
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 71

1. Torsional deformation of solid round shafts. Formula for angle of twist (proof). Condition of rigidity.
2. Generalized Hooke's law and its application for calculation of stresses, strains and relative change of elastic material volume.

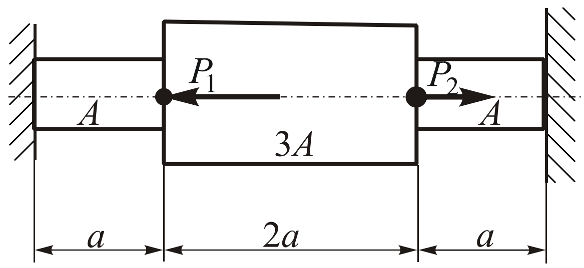
3.



Given: σ_1=150MPa, σ_3=100MPa, α=45°

Aim: calculate σ_α, τ_α, σ_β, τ_β.

4.



Given: a=1.0 m, P_1=40 kN, P_2=30 kN, $[\sigma]$=160 MPa.

Aim: determine internal forces N_x, calculate cross-sectional area A, determine acting stresses σ_x.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

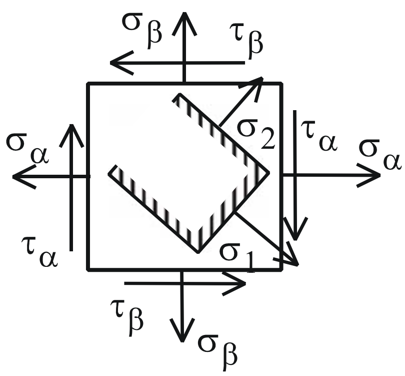
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester **III**

Course **"Mechanics of materials"**

Examination card № 72

1. Torsional deformation of solid round shafts. Formula for angle of twist (proof). Condition of rigidity.
2. Generalized Hooke's law and its application for calculation of stresses, strains and relative change of elastic material volume.

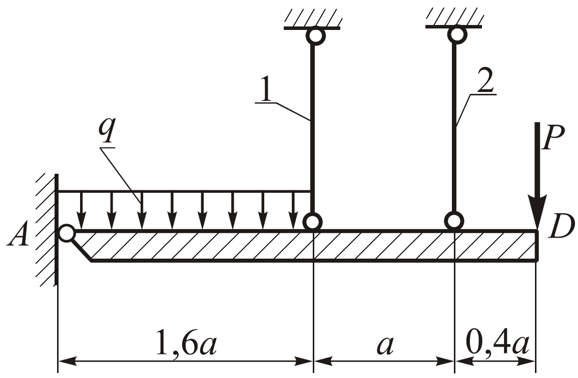
3.



Given: σ_α =100MPa, τ_α =60MPa, σ_β =50MPa

Aim: calculate σ_1, $\sigma_{2(3)}$, α_p.

4.



Given: *a=1 m, P=100 kN, q = 20kN/m, $d_1 = d_2 = d$, cross-section – round, [σ]=160 MPa , AD – absolutely rigid beam.*

Aim: calculate *d*.

Accepted by Department of Aircraft Strength meeting.

Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor **Fomichov P.O.**

Examiner **Demenko V.F.**