National aerospace university "Kharkiv Aviation Institute"

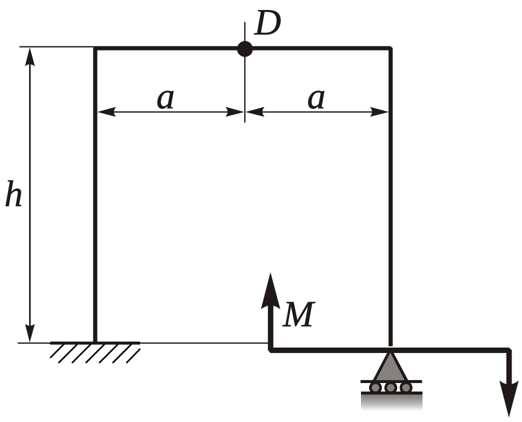
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 1

1. Generalized forces and displacements. Reciprocal theorems.
2. Influence of different boundary conditions on the magnitude of critical force. Length reduction factor.

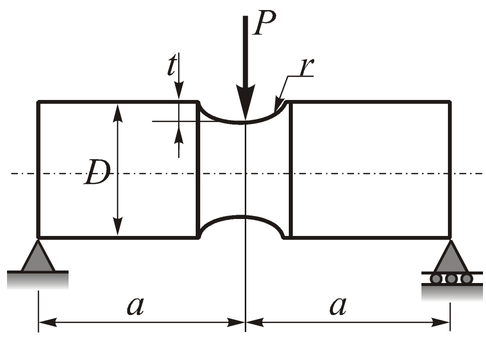
3.



Given: *a=1 m, h=2 m, M=20 kNm.*

Aim: calculate vertical displacement of *D*-point.

4.



Given: *a=1 m,*

$D = 10\times10^{-2}\,м$, $t = r = 10\times10^{-3}\,m$

$P_{max} = 15kN$, $P_{min} = -5kN$, *steel 40XH, polishing.*

Aim: calculate n_S in groove cross-section.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

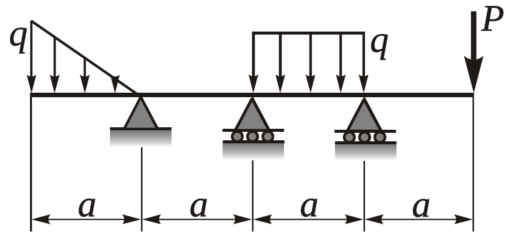
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 2

1. Reciprocal theorems (proof).
2. Fatique strength diagram.

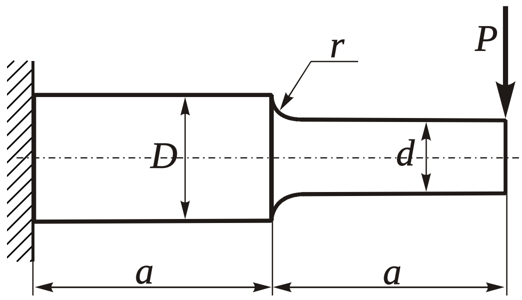
3.



<u>Given:</u> *a=1 m, P=10 kN, q=30 kN/m.*

<u>Aim:</u> design the graphs $Q_z(x), M_y(x)$.

4.



<u>Given:</u> *a=0.5 m, D/d=1.5, d=8 cm,* $P_{\max} = 10$ *kN,* $P_{\min} = -10$ *kN, r=0.1d, steel 40XH, rough polishing.*

<u>Aim:</u> calculate n_S in cross-section with fillet.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

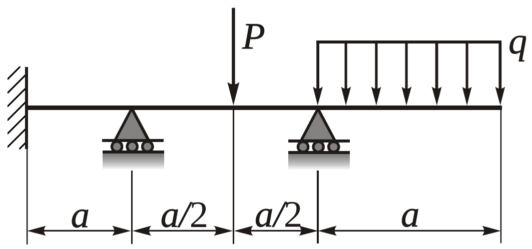
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 3

1. Determination of generalized displacements. Mohr’s integral (proof).
2. Fatigue of materials and its features.

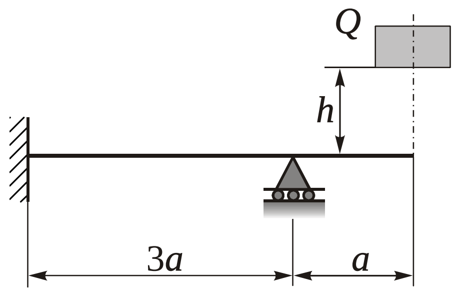
3.



<u>Given:</u> *a=2 m, q=4 kN/m, P=10 kN.*

<u>Aim:</u> design the graphs Q_z, M_y.

4.



<u>Given:</u> *a=1 m, Q=10 kN, h=0.02 m, I№20.*

<u>Aim:</u> calculate $s_{\max\, dyn}$.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

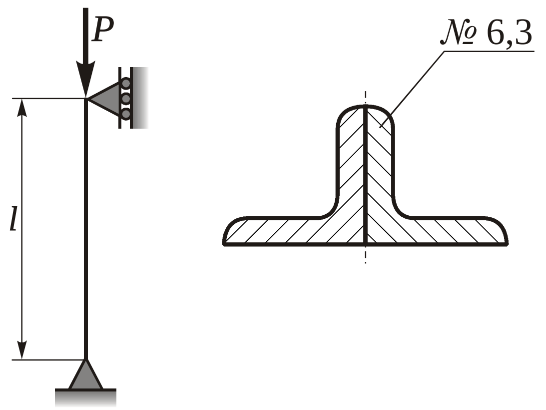
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 4

1. Vereschagin’s formula for calculating Mohr’s integral.
2. Fatigue strength diagram and limitations of its application in fatigue analysis.

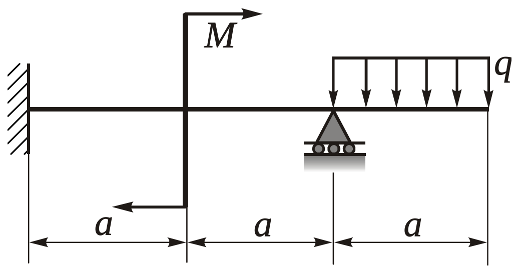
3.



Given: *l=2 m*, ∟№6,3(4), *material: steel Cm3*, $[s] = 160$ *MPa.*

Aim: calculate [*P*].

4.



Given: *a=2 m, q=20 kN/m, M=10 kN.*

Aim: design the graphs Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

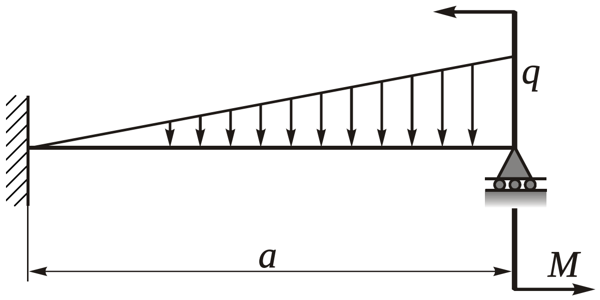
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 5

1. Force method. Canonical equations of the force method (proof).
2. Boundary conditions for Yasinski formula application.

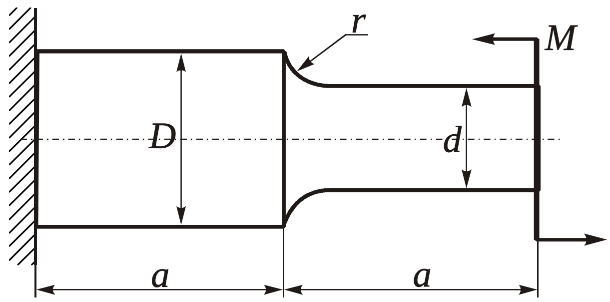
3.



<u>Given:</u> $a=3\ m$, $q=30\ kN/m$, $M=10\ kNm$, $[s]=160\ MPa$.

<u>Aim:</u> using force method, design the graphs Q_z, M_y, calculate diameter of round solid section.

4.



<u>Given:</u> $a=1\ m$, $D=8\times10^{-2}\ m$, $d=6\times10^{-2}\ m$, $r=0{,}6\times10^{-2}\ m$, $M_{\max}=20\ kNm$, $M_{\min}=-10\ kNm$, *18XH3A*, *rough polishing.*

<u>Aim:</u> calculate factor of safety in fatigue in cross-section with fillet.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

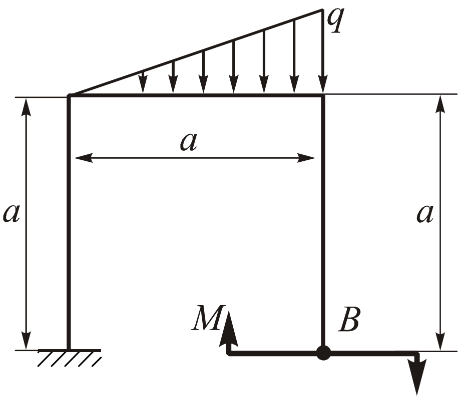
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 6

1. Multispan beams. Three moment equations (proof).
2. Determination of terms "generalized force" and "generalized displacement".

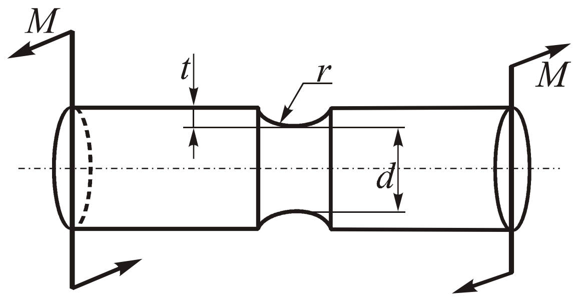
3.



Given: *a=1 m, q=30 kN/m , M=10 kNm,*
EI = const

Aim: calculate horizontal displacement of *B*-point.

4.



Given: $d = 8\times10^{-2}$ *m, t/r=1, r/d=0,1,*
$M_m = 5$ *kNm*, $M_a = 25$ *kNm, steel 30XH,*
rough polishing.

Aim: calculate factor of safety in cross-section with groove.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

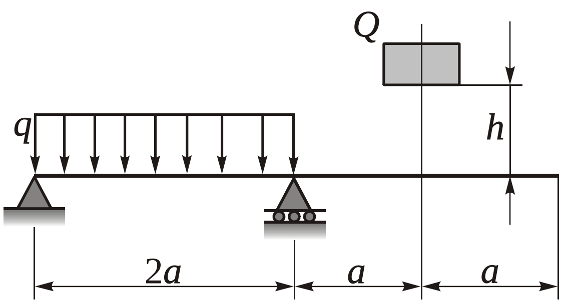
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 7

1. General features of fatigue failure of materials. General characteristics of the cycle of loading. Influence of different factors on fatigue limit.
2. Stress reduction factor, its determination and the features. Corresponding condition of stability.

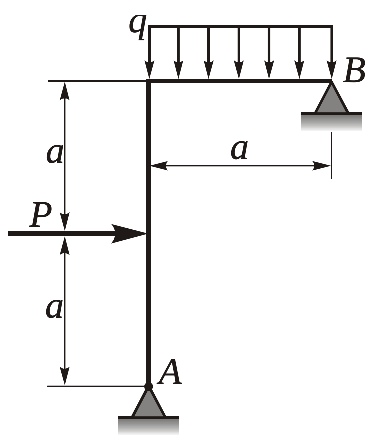
3.



Given: *a=1 m, q=30 kN/m , Q=1 kN, rectangle cross-section:* $h = 12 \times 10^{-2}$ *m,* $b = 6 \times 10^{-2}$ *m,* $E = 2 \times 10^{5}$ *MPa.*

Aim: calculate $s_{\max\, dyn}$

4.



Given: *a=2 m, P=20 kN, q=4 kN/m, I№18*

Aim: design the graphs N_x, Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

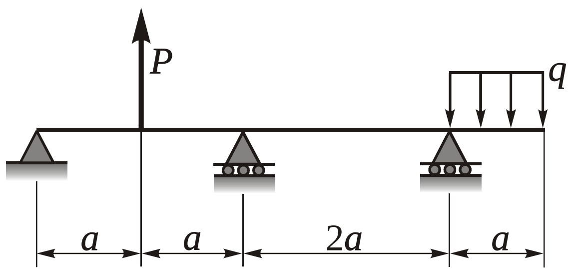
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 8

1. Experimental study of fatigue limit. Vohler’s curve. Influence of different factors on fatigue limit.
2. How to determine statical displacement (s_{st}) in the formula of dynamic factor?

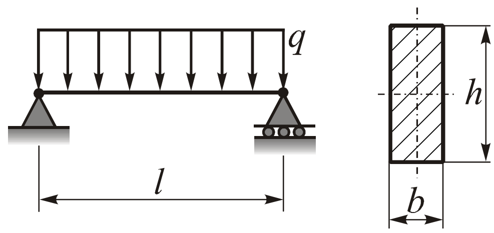
3.



<u>Given:</u> *a=1 m, q=2 kN/m , P=8 kN,* $EI_y = const$.

<u>Aim:</u> design the graphs Q_z, M_y.

4.



<u>Given:</u> *l=2 m,* $s_y = 240 MPa$, $h = 18 \times 10^{-2}$ *m,* $b = 9 \times 10^{-2}$ *m.*

<u>Aim:</u> calculate ultimate value of distributed load.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

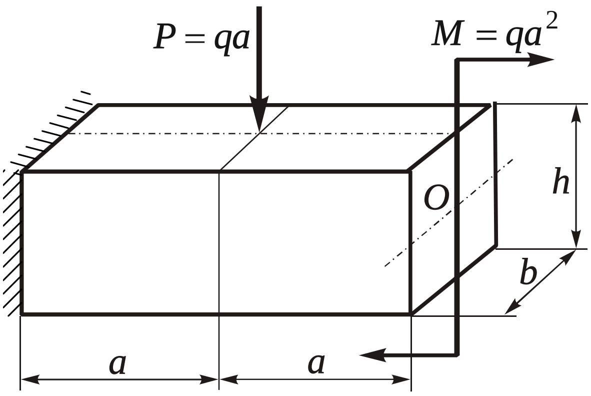
National aerospace university "Kharkiv Aviation Institute"

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **"Mechanics of materials"**

Examination card № 9

1. Factor of safety in fatigue, its theoretical and graphical calculation.
2. Effect of concentrated moments applied to multispan beam supports on the three moment equation.

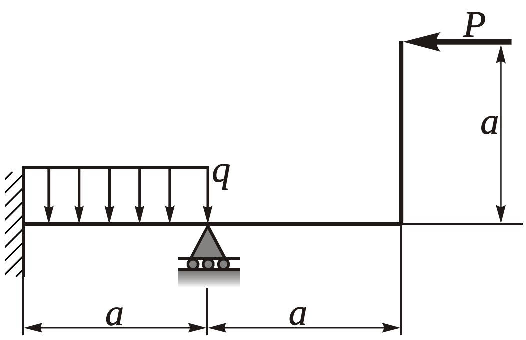
3.



Given: a=1 m, $b = 8\times10^{-2}$ m, $h = 16\times10^{-2}$ m, $q = 2$ kN/m, $E = 2\times10^{5}$ MPa.

Aim: calculate vertical displacement of O-point.

4.



Given: a=1 m, q=10 kN/m, P=10 kN.

Aim: design the graphs N_x, Q_z, M_y, using equation of three moments to open statical indeterminacy.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

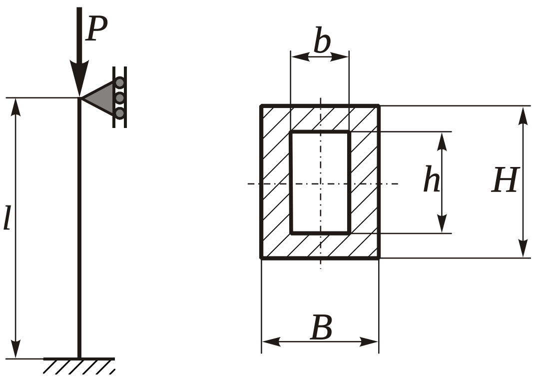
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 10

1. Boundary conditions in application of fatigue limit diagram to check fatigue strength of the cross-section with stress concentrator.
2. Vereschagin’s method and its application.

3.



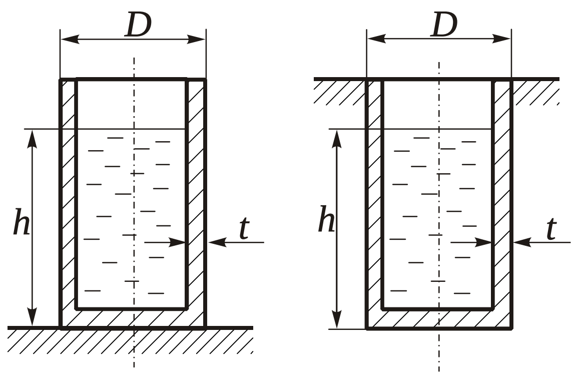
Given: $l=3\ m,\ b=6\times10^{-2}\ m,\ \ h=10\times10^{-2}\ m,$

$B=8\times10^{-2}\ m,\ \ H=12\times10^{-2}\ m,\ \ n_y=3.$

material steel *Cm3.*

Aim: calculate $P_{cr},[P]$

4.



Given: $h=1\ m, D=0.8\ m,\ \ r=10^3\ kg/m^3,$

$[s]=100\ MPa.$

Aim: calculate thickness of the wall *t* for two versions of vessel support.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

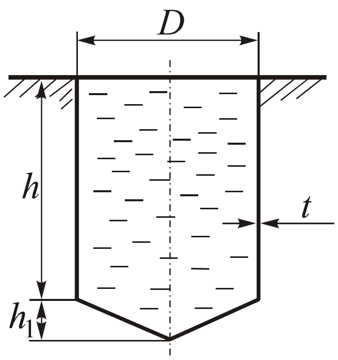
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 11

1. Fatigue strength diagram (method of design).
2. Oblique bending: method of critical point calculation.

3.

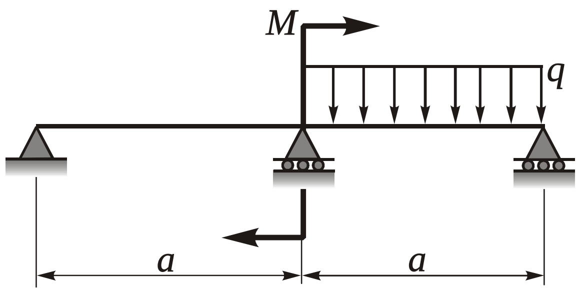


<u>Given:</u> $h=1\ m,\ h_1=0.5\ m,\ D=1\ m,$

$$r=10^3\ kg/m^3,\ t=0.5\times10^{-2}\ m.$$

<u>Aim:</u> determine stress distributions along the depth of cylindrical part.

4.



<u>Given:</u> $a=2\ m,\ q=14\ kN/m,\ M=20\ kNm.$

<u>Aim:</u> design the graphs Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

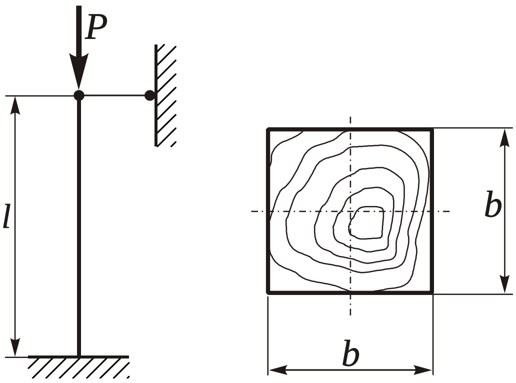
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 12

1. Stable and unstable equilibrium of elastic system. Euler’s formula (proof).
2. Fatigue limit and its experimental determination.

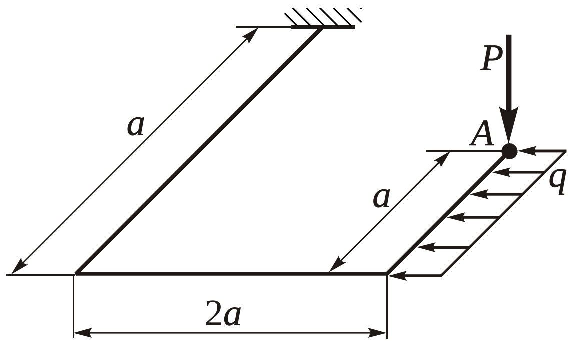
3.



<u>Given:</u> l=2 m, $b = 10\times10^{-2}$ m, P=15 kN,
$[s] = 10$ MPa, *material of the post – pine.*

<u>Aim:</u> check stability of pine.

4.



<u>Given:</u> a=1 m, q=2 kN/m, P=20 kN.
$[s] = 140$ MPa, $E = 2\times10^{5}$ MPa.

<u>Aim:</u> calculate diameter of round section of third portion.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

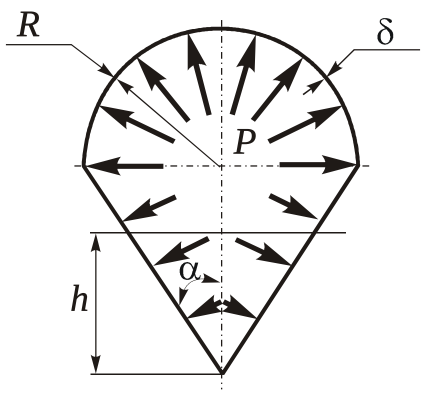
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 13

1. Influence of different boundary conditions on the value of critical force for compressed rod.
2. Assymetry factor in periodic loading. The most dangerous cycle of loading.

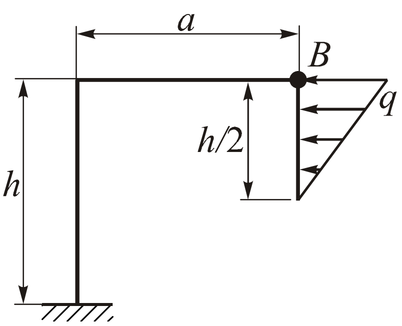
3.



<u>Given:</u> $R=2{,}5\ m,\ P=1{,}0\ MPa,\ d=2\times10^{-2}\ m,$
$a=60°,\ h=0{,}1\ m.$

<u>Aim:</u> calculate s_m, s_q at h depth.

4.



<u>Given:</u> $h=2\ m,\ a=2\ m,\ q=30\ kN/m,\quad EI_{n.a}=const.$

<u>Aim:</u> calculate angle of twist at B-point.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

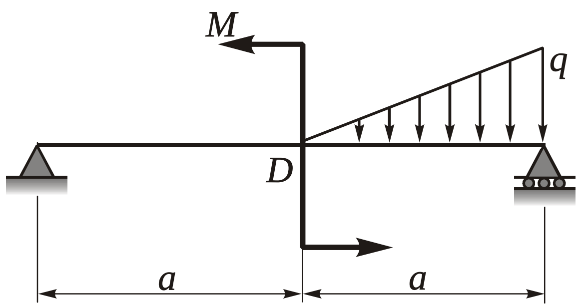
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 14

1. Diagram of critical stresses. Yasinski formula for critical stress determination and its limitations.
2. Method of determination of critical points in eccentric tension-compression.

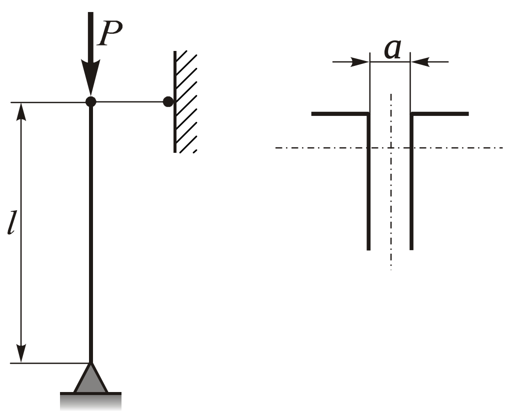
3.



Given: *a=1 m, q=20 kN/m, M=10 kN/m I№18,* $E = 2\times10^5$ *MPa.*

Aim: calculate vertical displacement of *D* point using Mohr's method.

4.



Given: *l=3 m, cross-section of the post – two nonequileg angles №14/9 (1),* $K = 2.5$, $a = 4\times10^{-2}$ *m, material – steel Cm3.*

Aim: calculate $P_{cr}, [P]$.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

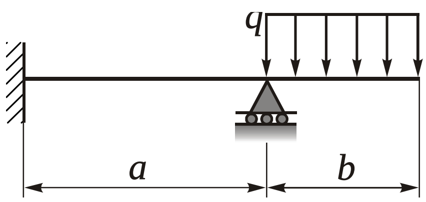
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 15

1. Two methods of critical force calculation. Conditions of stability. Direction of buckling and its prediction.
2. Ways of fatigue strength improvement.

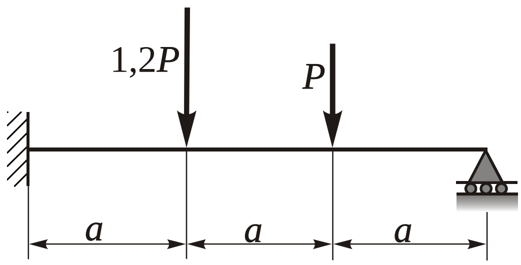
3.



Given: $a=4$ m, $b=2$ m, $q=10$ kN/m.

Aim: design the graphs Q_z, M_y.

4.



Given: $a=1$ m, I№16, $s_y = 300MPa$.

Aim: calculate ultimate 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

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

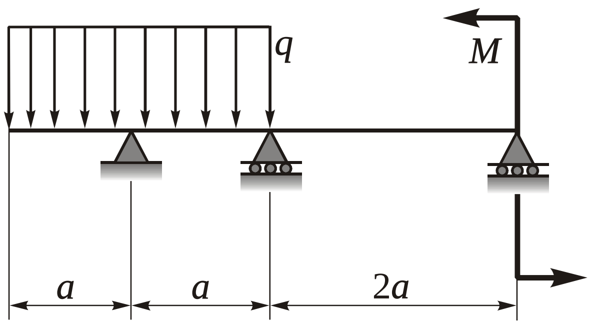
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 16

1. Stability of equilibrium of the rod in compression. Euler's formula (proof).
2. Theoretical and effective stress concentration factors.

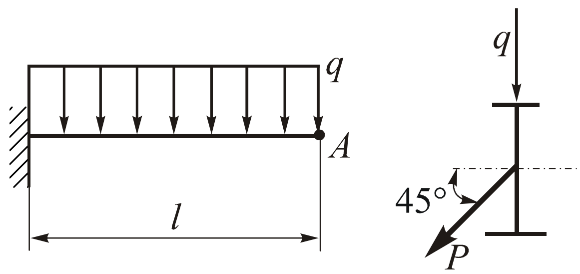
3.



Given: *a=1.5 m, q=2 kN/m, M=6 kNm*
$EI_y = const$.

Aim: design the graphs $Q_z(x), M_y(x)$.

4.



Given: *l=2 m, q=10 kN/m, P=10 kN,*
$E = 2 \cdot 10^{11}$ *Pa*, *IN40* (force *P* is applied at *A*-point).

Aim: calculate resultant linear displacement of *A*-point.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

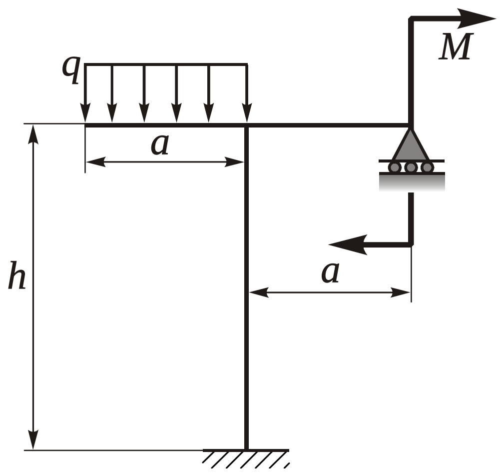
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 17

1. Laplace formula for stresses in thin-walled shell under internal pressure (proof).
2. General characteristics of the cycle of loading.

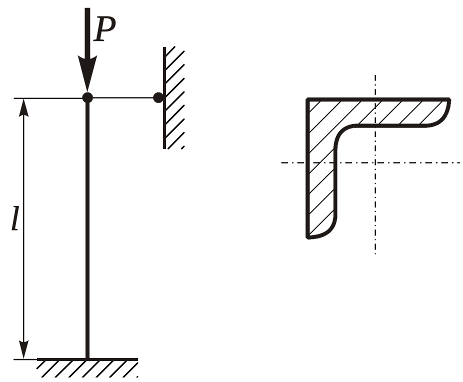
3.



Given: *a=1 m, h=2 m, q=30 kN/m, M=20 kNm.*

Aim: design the graphs N_x, Q_z, M_y.

4.



Given: *l=2 m, P=180 kN,* $[s]=160$ *MPa, material – steel Cm3.*

Aim: determine the number of equileg angle profile.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

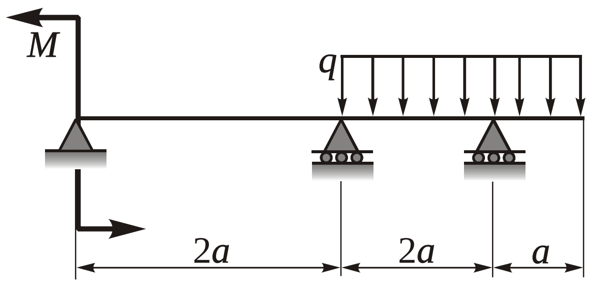
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 18

1. Third strength theory and corresponding condition of strength.
2. Method of meridional stress calculating in thin-walled shells.

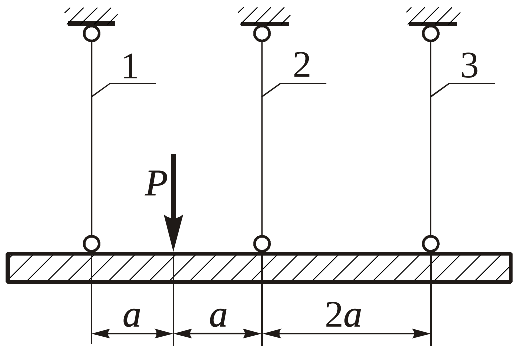
3.



<u>Given:</u> *a=1 m, q=2 kN/m, M=1 kNm.*

<u>Aim:</u> design the graphs Q_z, M_y

4.



<u>Given:</u> *AB – absolutely rigid beam,*

$$A_1 = A_2 = A_3 = A = 2\times10^{-4}\,m^2$$

$$s_y = 300MPa, K = 2$$

<u>Aim:</u> calculate allowable force [*P*].

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

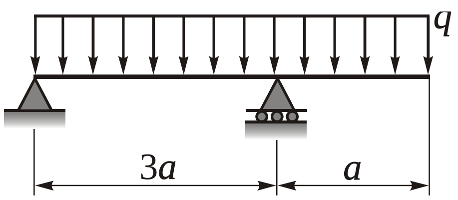
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 19

1. Laplace formula (proof) and its application for calculating stresses in spherical pressure vessel.
2. The term of "stress concentrator".

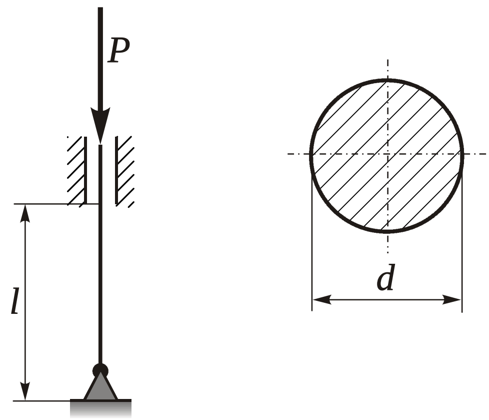
3.



Given: a=1 m, *I№20*, $s_y = 200MPa$.

Aim: calculate ultimate value of loading q_{ult}.

4.



Given: l=2 m, P=40 kN, $[s]_c = 160$ MPa, *material – steel Cm5.*

Aim: calculate diameter of cross-section *d.*

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

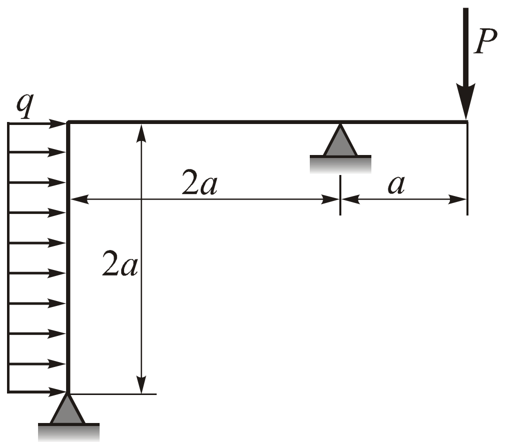
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 20

1. Vereschagin formula for calculating Mohr’s integral (proof).
2. Superposition principle and its application in stress analysis.

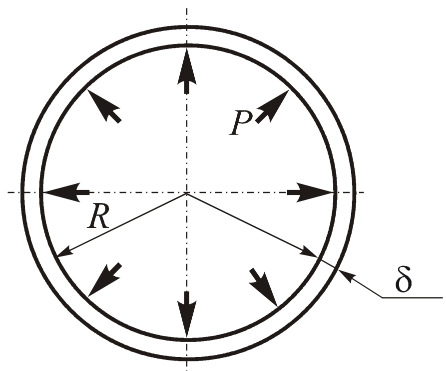
3.



<u>Given:</u> *a=1 m, q=2 kN/m, P=3 kN, EI=const.*

<u>Aim:</u> design the graphs N, Q_z, M_y.

4.



<u>Given:</u>*R=0.2 m, $d = 0.002$ m, $[s] = 150$ MPa.*

<u>Aim:</u> calculate allowable value of pressure [*P*].

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

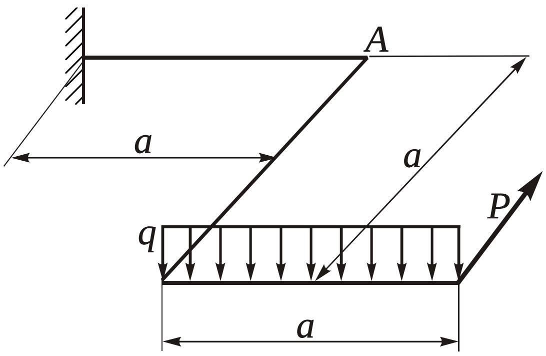
Degree B. Sc.   Branch of education: 1001 **Aerospace Engineering**   Semester ***IV***

Course   **“Mechanics of materials”**

Examination card № 21

1. Diagram of critical stresses in buckling and its applicability in solution of the stability problems.
2. General assumptions in Laplace formula proof.

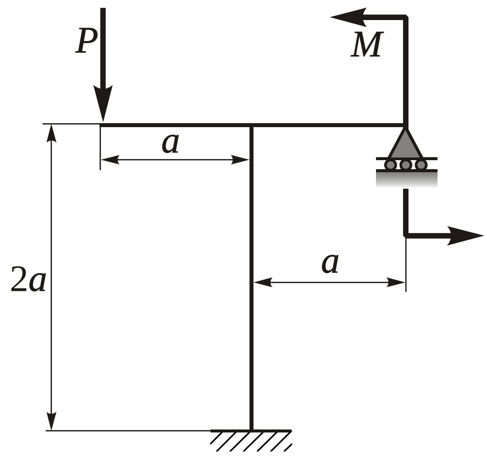
3.



<u>Given:</u> *a=1 m*, [*s*]=*160 MPa*, *P = 10 kN*, *q=10 kN/m.*

<u>Aim:</u> calculate diameter of round section of third portion.

4.



<u>Given:</u> *l=1.5 m, [№18, material – steel Cm3, P=5 kN, M=20 kNm, a=1 m.*

<u>Aim:</u> design the graphs N_x, Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

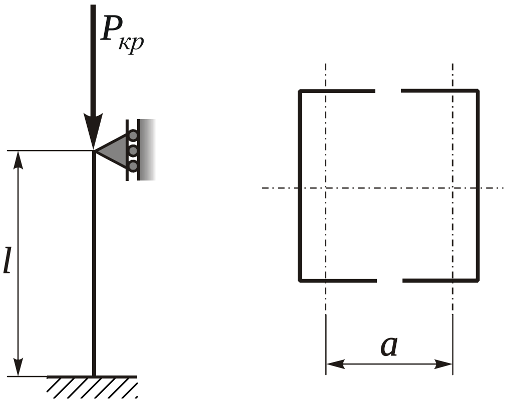
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 22

1. Laplace formula for calculating stresses in thin-walled shell (proof).
2. Nominal and local stresses. Theoretical and effective stress concentration factors.

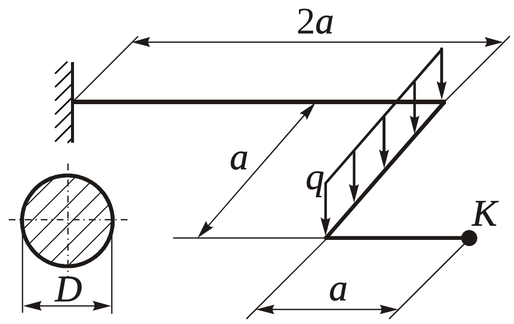
3.



Given: *l=2 m, [№20, material – steel 45.*

Aim: calculate optimal value of the distance *a* from the viewpoint of equistability and critical force P_{cr}

4.



Given: $a=0.4$ m, $q=10$ kN/m, $D=18\times10^{-2}$ m, $E=2\times10^{5}$ MPa, $G=8\times10^{4}$ MPa.

Aim: calculate vertical displacement of *K*-point.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

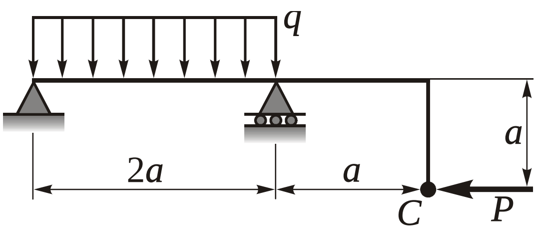
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 23

1. Method of thin-walled shell stress state analysis under hydraulic pressure (proof of the equations and analysis of stress distribution along the vertical axis of the shell).
2. Limitations of Euler's formula application. Dependence of critical stress on actual slenderness ratio of a post.

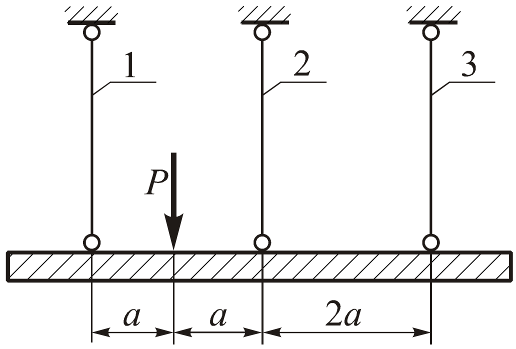
3.



Given: *a=1 m, q=6 kN/m, P=8 kN, round cross-section, d=0.1 m,* $E = 2\times10^5$ *MPa*.

Aim: calculate angle of twist of *C*-section.

4.



Given: *AB – absolutely rigid beam,*

$$A_1 = A_2 = A_3 = A = 2\times10^{-4}\,m^2$$

$$s_y = 300MPa, K = 2$$

Aim: calculate allowable force [P].

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

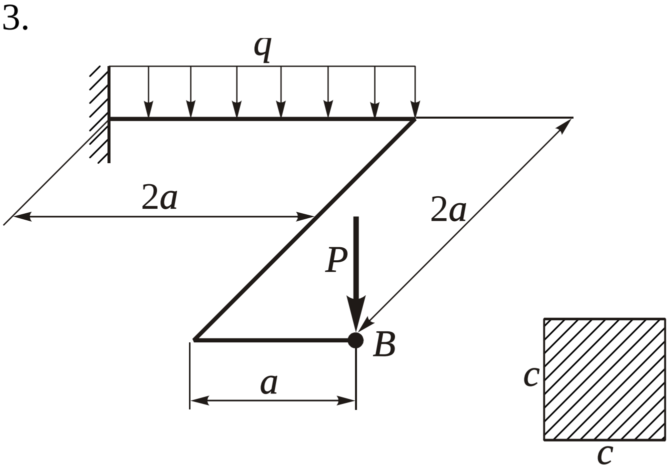
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 24

1. Theories (hypothesys) of strength. Conditions of strength for principal planes.
2. The concept of critical force.

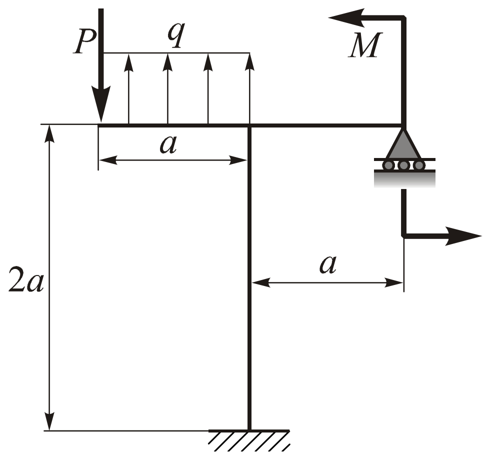
3.



Given: *a=1 m, q=10 kN/m P=10 kN,*
$c = 8\times10^{-2}$ *m (square cross-section),*
$G = 8\times10^{4}$ *MPa*, $E = 2\times10^{5}$ *MPa*.

Aim: calculate vertical displacement of *B*-point.

4.



Given: *a=1 m, P=10 kN, M=6 kNm, q=10 kN/m.*

Aim: design the graphs N_x, Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

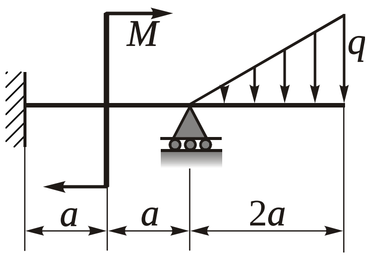
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 25

1. Eccentric tension-compression of the rod. Calculation of acting stresses in an arbitrary section, condition of strength and neutral axis position.
2. General assumptions in proof of dynamic factor formula.

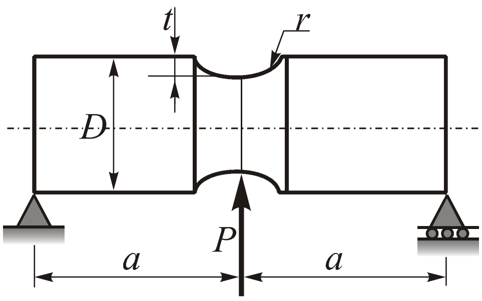
3.



Given: a=2 m, q=30 kN/m, M=25 kNm.

Aim: design the graphs Q_z, M_y.

4.



Given: a=1 m, $D=10\times10^{-2}$ m, t=r,
$P_{\max}=15$ kN, $P_{\min}=-5$ kN,
$r=0.6\times10^{-2}$ m, steel 50XH, grinding.

Aim: calculate n_s in groove section.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

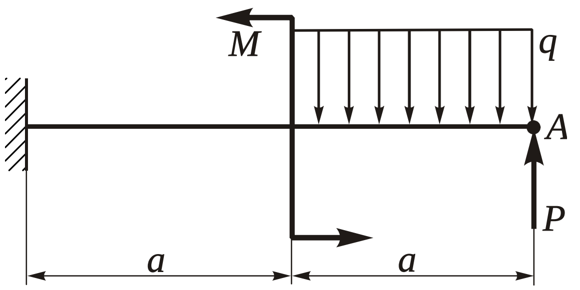
Degree B. Sc.   Branch of education: 1001 **Aerospace Engineering**   Semester ***IV***

Course   **"Mechanics of materials"**

Examination card № 26

1. Stresses at impact loading. Proff the formula for dynamic factor.
2. The concepts of base and equivalent systems in the force method (as examples).

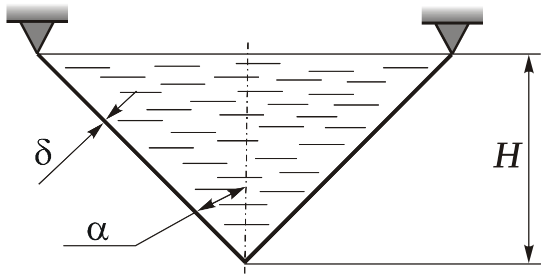
3.



Given: *a=2 m, q=30 kN/m, M=10 kNm, P=10 kN, EI=const.*

Aim: calculate vertical displacement of *A*-point.

4.



Given: $H=1\ m$, $a = 45°$, $d = 1\times10^{-2}\ m$, $r = 10^3\ kg/m^3$.

Aim: design the graph of s_q distribution along vertical axis of the shell.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

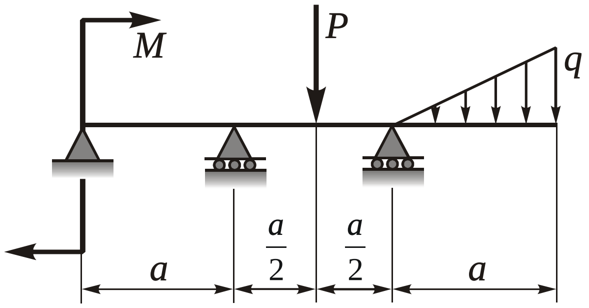
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 27

1. Strength analysis in buckling using stress reduction factor $f(l)$. Condition of stability and the problems which are solved using this condition.
2. The concepts “oblique bending” and “eccentric tension-compression” and their particularities. Method of stress analysis in oblique bending and eccentric tension-compression.

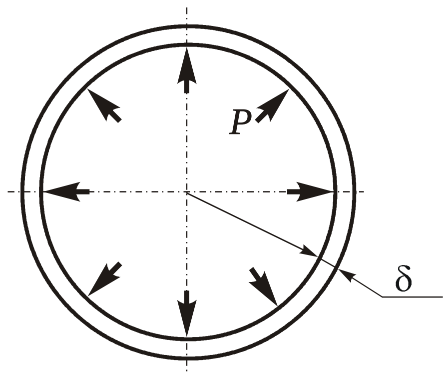
3.



<u>Given:</u> *a=3 m, q=20 kN/m, P=10 kN, M=20 kNm.*

<u>Aim:</u> design the graphs Q_z, M_y.

4.



<u>Given:</u> *R=0.2 m, P=10 MPa,* $[s] = 150$ *MPa*.

<u>Aim:</u> calculate thickness d.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

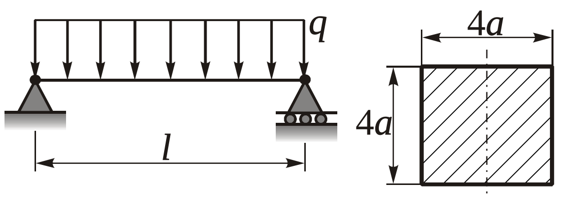
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 28

1. Essence of the force method, its general features and particularities (examples).
2. Limitations on Euler formula application.

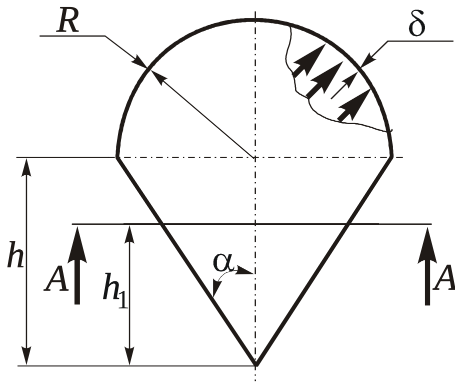
3.



Given: $a = 4\times10^{-2}$ *m, l=2 m,* $s_y = 240 MPa$, *n=2.*

Aim: calculate ultimate and allowable values of distributed load $\left(q_{ult}, [q]\right)$.

4.



Given: *R=0,5 m, P=30 MPa,* $d = 2\times10^{-2}$ *m*, *h=0,5 m,* h_1*=0,1 m,* $a = 45°$.

Aim: calculate acting stresses in A-A section.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

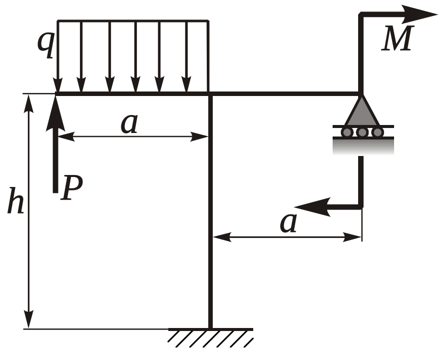
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 29

1. Graphical method of factor of safety canculation in periodical loading.
2. Allowable stress in stability and its determination using stress reduction factor.

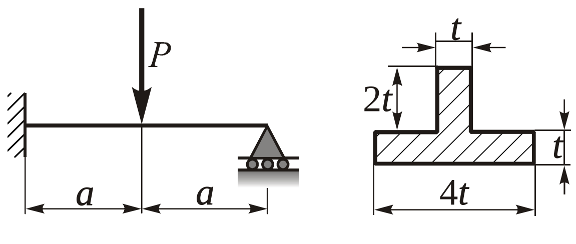
3.



<u>Given:</u> *a=1 m, h=2 m, q=20 kN/m, M=20 kNm, P=10 kN.*

<u>Aim:</u> design the graphs N_x, Q_z, M_y.

4.



<u>Given:</u> a=1 m, $t = 4\times10^{-2}$ m, , $K = 1{,}5$.

<u>Aim:</u> calculate P_{ult} and [P].

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

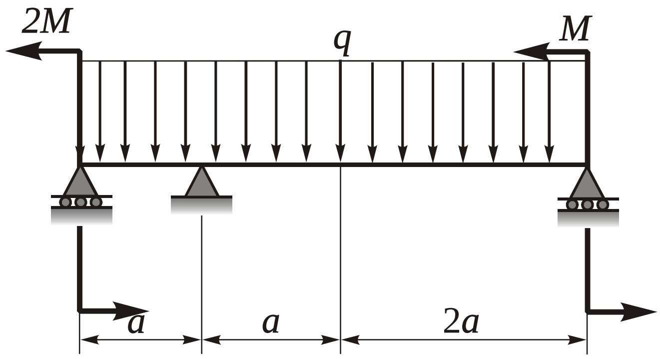
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 30

1. Proof of Euler formula for critical force calculation.
2. Stress analysis of multispan beams (an example of three moment equation application).

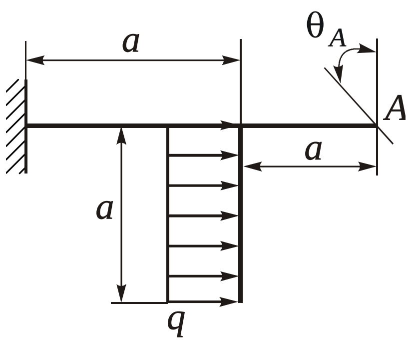
3.



Given: *a=1.5 m, q=2 kN/m, M=6 kNm* $EI_y = const$.

Aim: desigh the graphs Q_z, M_y.

4.



Given: *a=2 m,* $E = 2\times10^5$ *MPa, cross-section – rectangle,* ($b = 8\times10^{-2}$ *m*, $h = 16\times10^{-2}$ *m*), $q_A = 0.01\ rad$.

Aim: calculate the intensity of external load *q*, which creates specified value of q_A.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

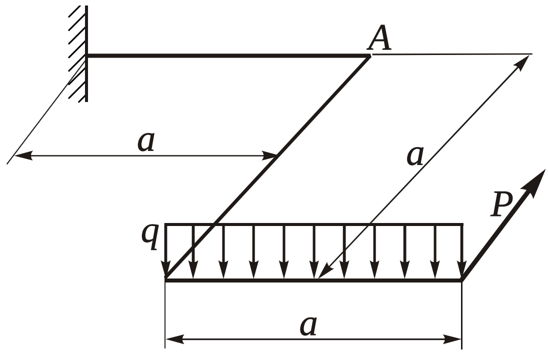
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 31

1. Second strength theory and its application.
2. Assumptions in Laplace formula proof.

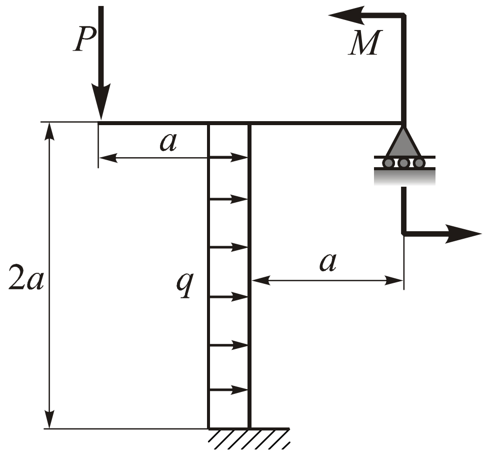
3.



Given: *a=1 m, P=20 kN, q=10 kN/m,*
[s]=160 MPa.

Aim: calculate dimensions of square cross-section in third portion.

4.



Given: *a=1 m, P=10 kN, M=6 kNm, q=10 kN/m.*

Aim: design the graphs N_x, Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

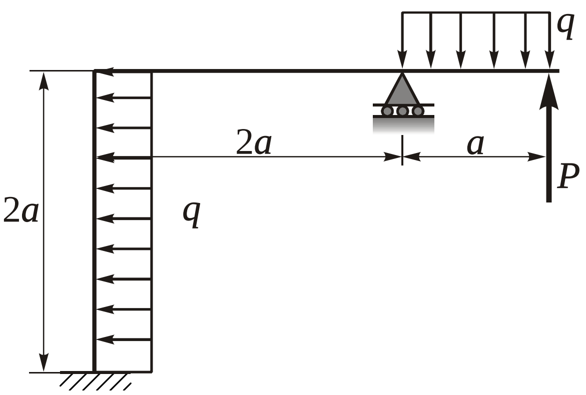
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 32

1. Forth strength theory and conditions of strength for planes of general position and principal planes.
2. Eccentric tension-compression: method of critical point determination. Condition of strength.

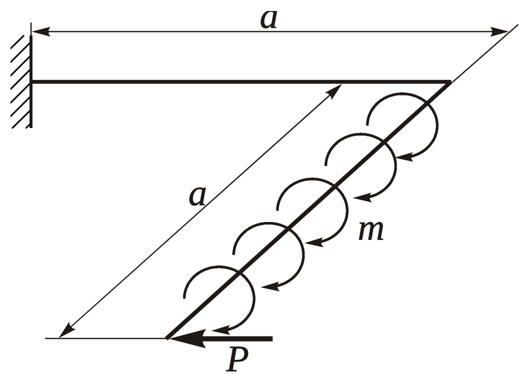
3.



Given: *a=1 m, P=10 kN, q=10 kN/m.*

Aim: design the graphs N_x, Q_z, M_y

4.



Given: *m=10 kNm/m, P=10 kN,* $[s]=160$ *MPa, a=2 m.*

Aim: calculate diameter of second portion.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

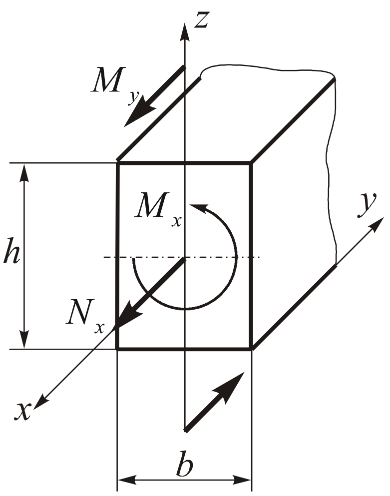
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 33

1. Third strength theory, its limitation and condition of strength.
2. Oblique bending, its features and method of critical point determination. Condition of strength.

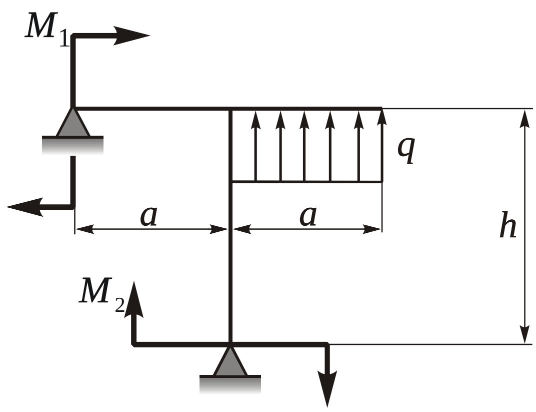
3.



Given: $M_x = 10$ *kNm*, $M_y = 20$ *kNm*, $N_x = 10$ *kN*, $[s] = 200$ *MPa*, *h/b=2.*

Aim: calculate dimensions of cross-section.

4.



Given: *a=1 m, h=2 m,* $M_1 = 10$ *kNm,* $M_2 = 20$ *kNm, q=10 kN/m.*

Aim: design the graphs N_x, Q_z, M_y

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

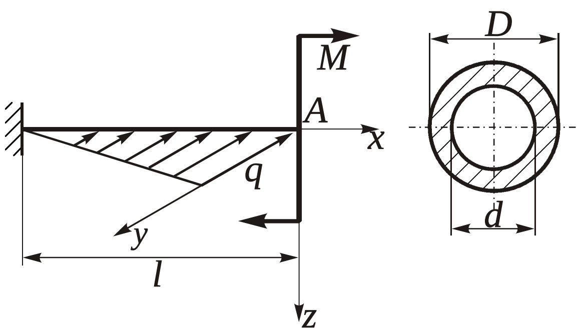
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 34

1. Force method for opening the statical indeterminacy of rod systems. An example of presentation.
2. Description of oblique bending and eccentric tension-compression deformations. Position of neutral axis.

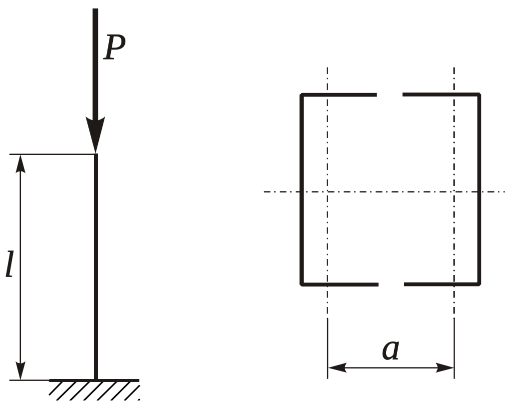
3.



Given: $a = d / D = 0.8$, $[s] = 160\ MPa$,
q=10 kN/m, l=3 m, M=10 kNm.

Aim: calculate diameters *d and D.*

4.



Given: *l=2 m,* channel *N24, material – steel 20.*

Aim: calculate optimal size a from the viewpoint of post equistability and the value of critical force P_{cr}.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

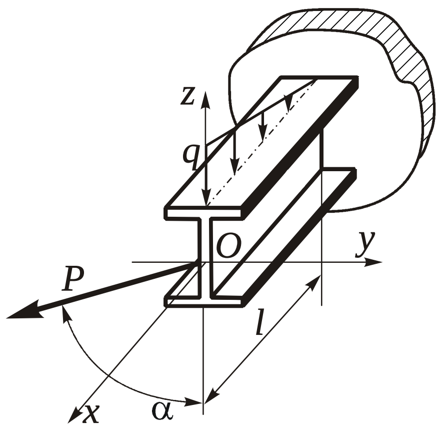
Degree B. Sc.   Branch of education: 1001   **Aerospace Engineering**   Semester   ***IV***

Course   **“Mechanics of materials”**

Examination card № 35

1. Third strength theory: determination of equivalent stresses, condition of strength for planes of general position and principal planes..
2. Oblique bending: determination of critical points and critical stresses. Condition of strength.

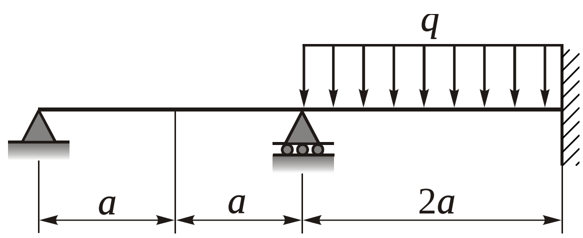
3.



<u>Given:</u> IN16, *q*=10 *kN/m*, *P*=10 *kN*, *l*=2 *m*, $[s]=160$ *MPa*, $a=30°$ (in *YOZ* plane).

<u>Aim:</u> check strength of the beam.

4.



<u>Given:</u> *q*=20 *kN/m*, *a*=1 *m*.

<u>Aim:</u> design the graphs $Q_z(x), M_y(x)$ (use three moment equations).

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner   **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

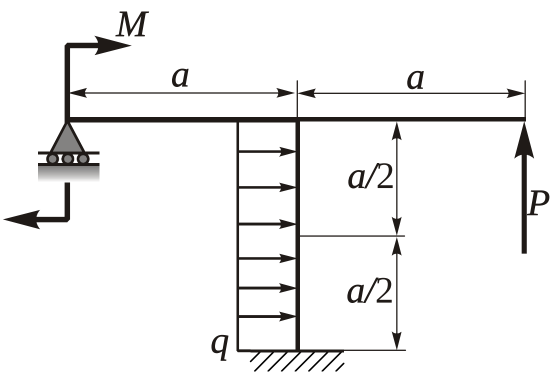
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 36

1. Proof of the reciprocal theorem.
2. Selection of equivalent system in force method and geometrical sense of canonical equations.

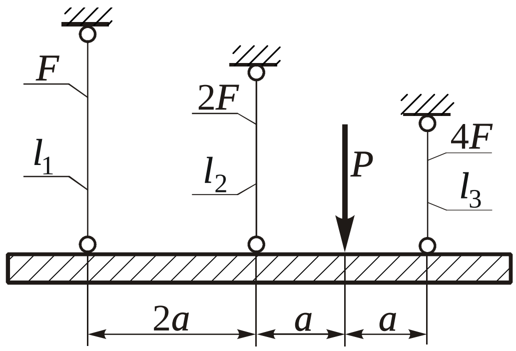
3.



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

Aim: design the graphs N_x, Q_z, M_y.

4.



Given: $A=1\ cm^2$, $s_y = 150\ MPa$, $l_1 = 3\ m$, $l_2 = 2\ m$, $l_3 = 1\ m$, $a=2\ m$, $n=2$.

Aim: calculate ultimate force *P*.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

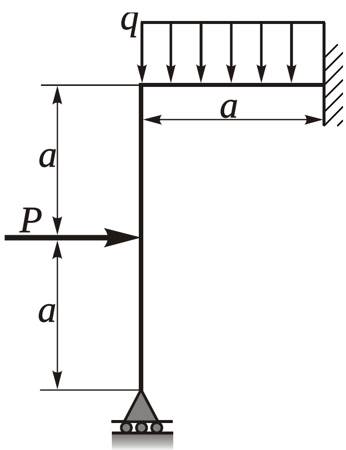
National aerospace university "Kharkiv Aviation Institute"

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **"Mechanics of materials"**

Examination card № 37

1. Canonical equations of the force method (proof).
2. Conditions of Euler formula applicability.

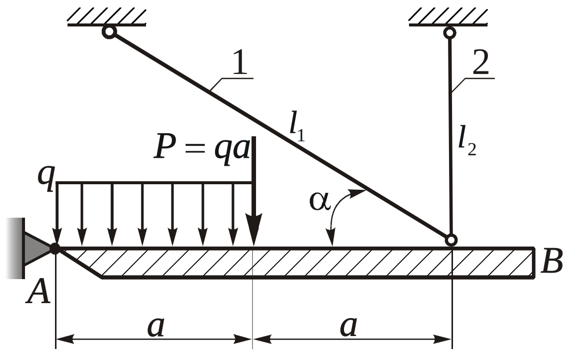
3.



Given: P=10 kN, q=10 kN/m, a=2 m.

Aim: design the graphs N_x, Q_z, M_y.

4.



Given: $l_2 = 2$ m, $\alpha = 30°$, a=2 m,
$A_1 = A_2 = A = 2$ cm^2, $\sigma_y = 200$ MPa,
n=2.

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

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

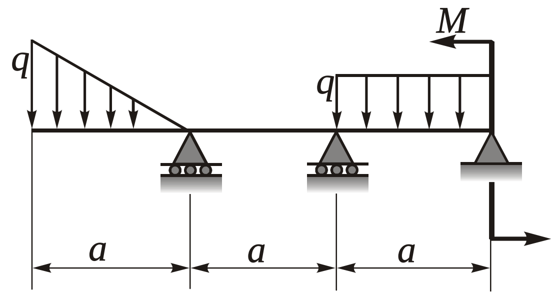
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 38

1. Three moment equation (proof).
2. Factors which influence the value of stress reduction factor in buckling analysis.

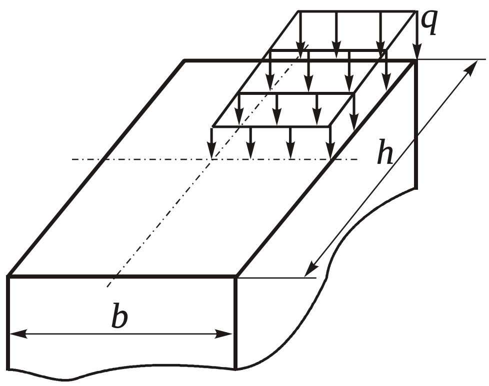
3.



Given: q=30 kN/m, a=2 m, M=40 kNm.

Aim: design the graphs Q_z, M_y.

4.



Given: q=10 kN/m^2, b=4 cm, h=8 cm.

Aim: design the graph of stress distribution in an arbitrary cross-section and calculate maximum stresses.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

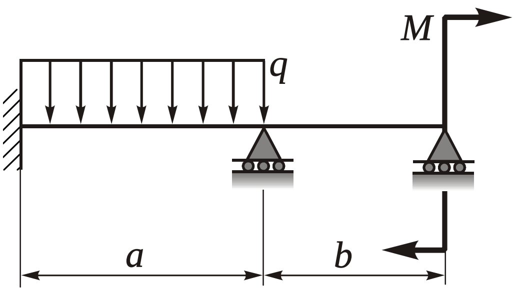
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 39

1. Proof of the three moment equation in opening of statical indeterminacy of multispan beams.
2. Concept of theoretical stress concentration factor.

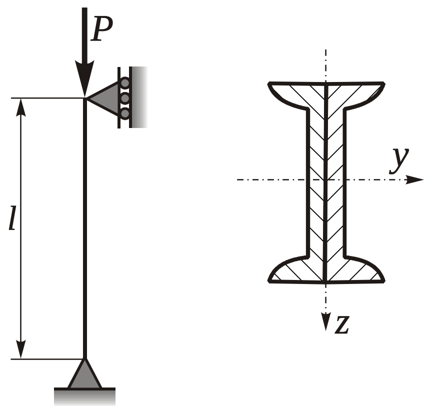
3.



<u>Given:</u> M=20 *kNm*, q=20 *kN/m*, a=2 *m*.

<u>Aim:</u> design the graphs $Q_z(x), M_y(x)$.

4.



<u>Given:</u> two channels N12, l=2 *m*, P=20 *kN*, $[s]_c = 200\ MPa$.

<u>Aim:</u> check stability of the post.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

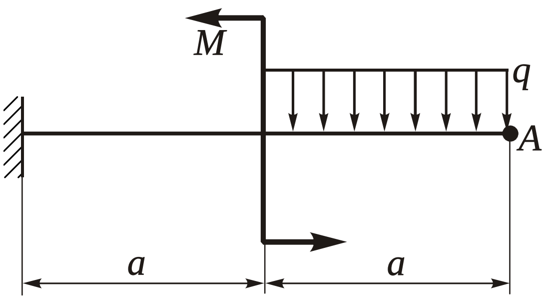
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 40

1. Proof of the Euler formula in analysis of the rod buckling.
2. The concept of material fatigue limit and its experimental study.

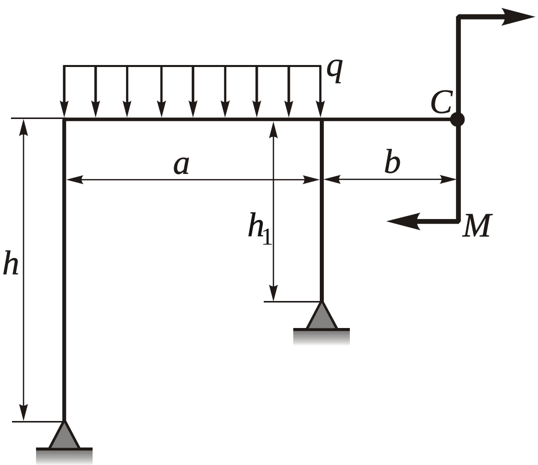
3.



Given: a=2 *m*, q=20 *kN/m*, M=40 *kNm*, $E = 2 \cdot 10^{11}$ *Pa*, cross-section – round, $d = 10$ *cm*.

Aim: calculate vertical displacement of A-point.

4.



Given: q=20 *kN/m*, a=2 *m*, b=1 *m*, h=4 *m*, $h_1 = 3$ *m*, M=40 *kNm*.

Aim: design the graphs N_x, Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

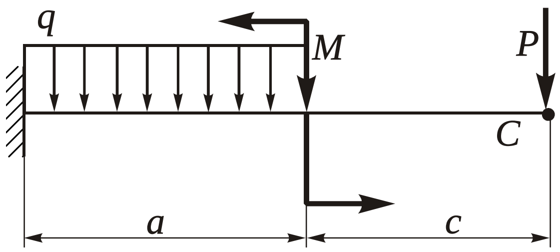
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 41

1. Influence of different boundary conditions on the magnitude of critical force.
2. Concept of stress reduction factor in buckling problem.

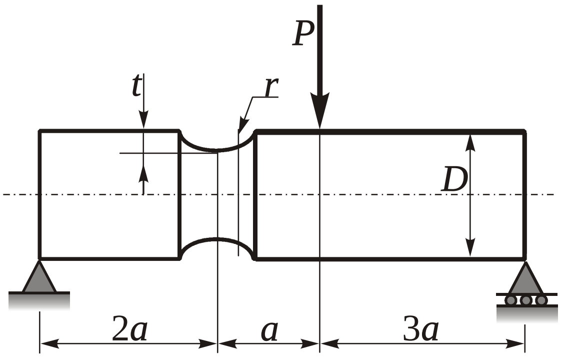
3.



Given: a=2 m, c=3 m, P=10 kN, M=40 kNm, $E = 2\cdot10^{11}$ Pa, cross-section – rectangle (b=4 cm, h= 8 cm).

Aim: calculate angle of rotation of C-section.

4.



Given: $P_{max} = 15$ kN, $P_{min} = -8$ kN, a=1 m, $D = 10$ cm, $t = r$, $r = 0{,}6$ cm, steel 50XH, grinding.

Aim: calculate n_s in groove cross-section.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

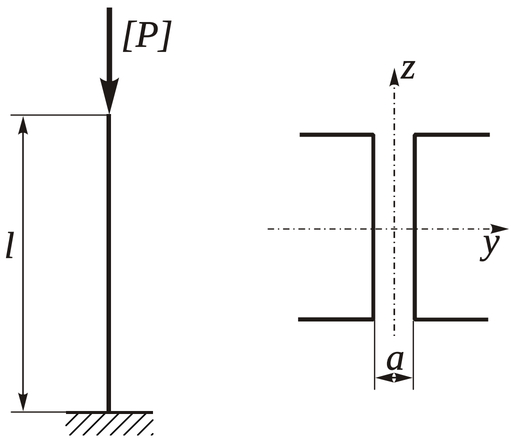
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 42

1. Stresses in axysymmetrical thin-walled shell under uniform or hydraulic pressure. Laplace formula (proof).
2. Nominal and local stresses: essence and distinction.

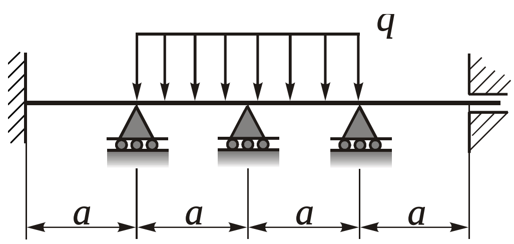
3.



<u>Given:</u> two channels IN14, a=2 *cm*, l=4 *m*, $[s]_c = 200$ *MPa*.

<u>Aim:</u> calculate allowable load $[P]$.

4.



<u>Given:</u> a=2 *m*, cross-section – round, d=5 *cm*, $s_y = 200$ *MPa*.

<u>Aim:</u> calculate ultimate external load.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

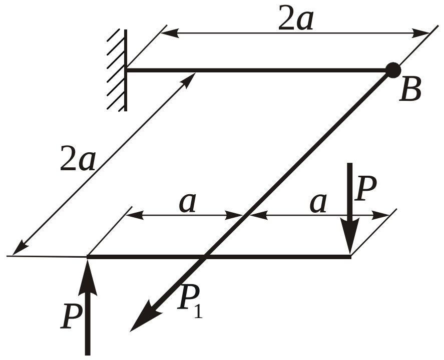
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 43

1. Proof of the reciprocal theorems.
2. External bending moments at left and right supports in three moment equation.

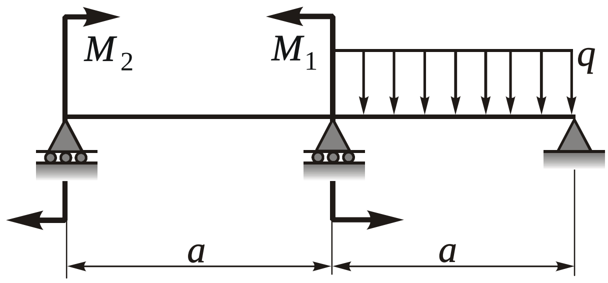
3.



Given: P=10 *kN*, $P_1 = 20$ *kN*, a=2 *m*,
$\left[s\right] = 160$ *MPa*, cross-section – square (5×5 *cm*).

Aim: check the strength of fourth portion.

4.



Given: q=10 *kN/m*, $M_1 = 20$ *kNm*, $M_2 = 40$ *kNm*, a=2 *m*.

Aim: design the graphs $Q_z(x), M_y(x)$.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

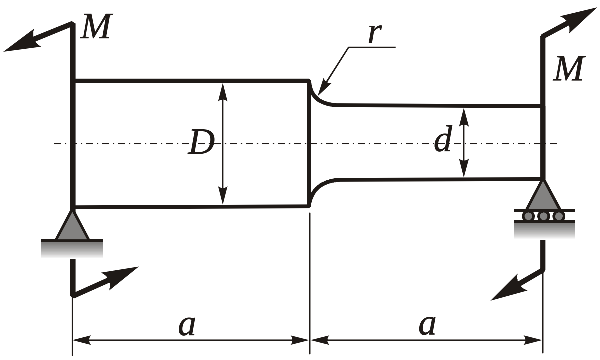
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 44

1. Method of buckling problem solution based on the concept of critical load. Condition of stability.
2. Concept of asymmetry factor.

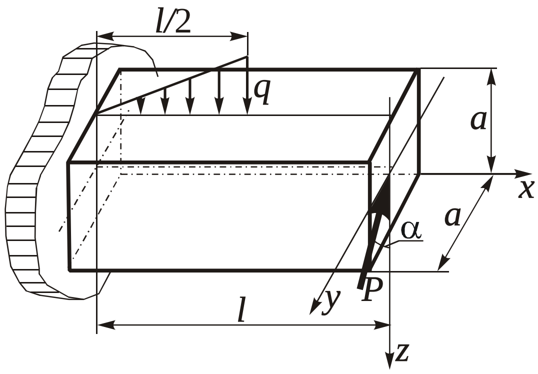
3.



Given: a=1 m, $M_{max} = 20\ kNm$, $M_{min} = -30\ kNm$, $D = 9\ cm$, $d = 6\ см$, $r = 0{,}1d$, material – steel 18XH, polishing.

Aim: calculate n_t in cross-section with fillet.

4.



Given: q=20 kN/m, l=6 m, P=10 kN, $a = 30°$, a=10 cm.

Aim: find critical section and draw the graph of stress distribution in it. Determine position of neutral axis.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

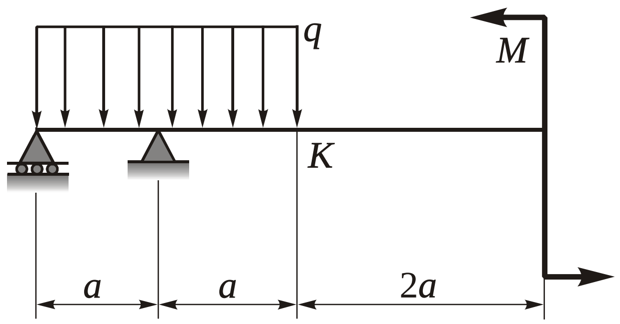
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 45

1. Method of stress analysis in buclking based on the stress reduction factor $f(l)$.
2. Diagram of critical stresses in buckling. Short, intermediate, and high flexible posts accordingly to the diagram of critical stresses.

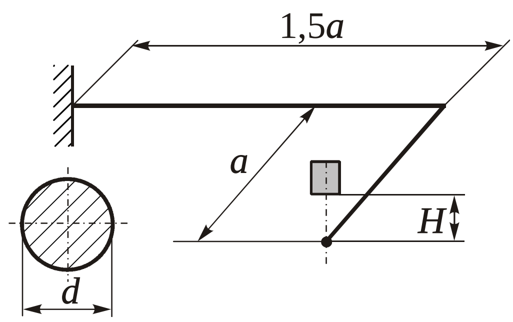
3.



Given: *M*=40 *kNm*, *q*=20 *kN/m*, *a*=2 *m*.

Aim: draw the graphs $Q_z(x), M_y(x)$.

4.



Given: *H*=2 *cm*, *a*=1 *m*, *d*=6 *cm*.

Aim: calculate maximum dynamic stress

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

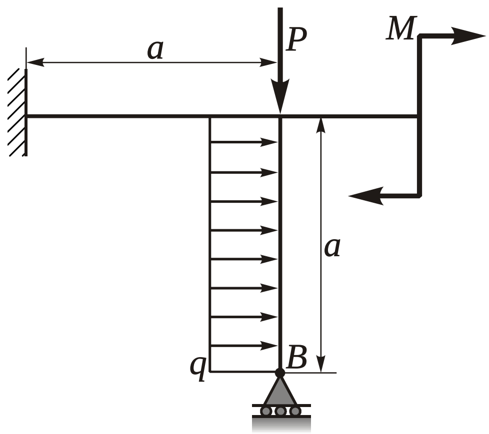
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 46

1. General case of rectangle cross-section loading. Finding the critical points and conditions of strength.
2. Conditions of Euler formula applicability.

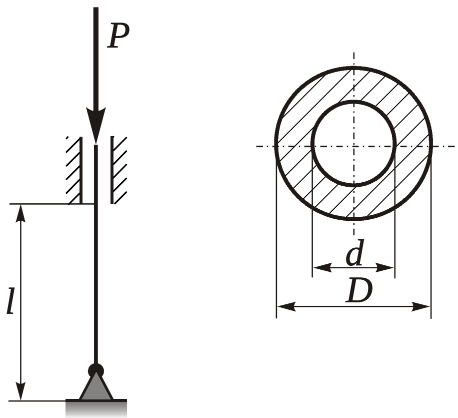
3.



__Given:__ *q*= 10 *kN/m*, *P*=20 *kN*, *a*=2 *m*, *M*=40 *kNm*.

__Aim:__ draw the graphs $N_x(x)$, $Q_z(x), M_y(x)$.

4.



__Given:__ *d*= 6*cm*, *D*=7 *cm*, *l*=4 *m*, $s_{pr} = 160$ *MPa*.

__Aim:__ calculate critical force for the post.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

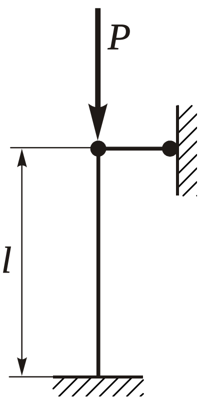
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 47

1. Method of experimental study of fatigue limit. Vohler's curve.
2. Essence of stress analysis in dynamic loading. Concept of dynamic factor.

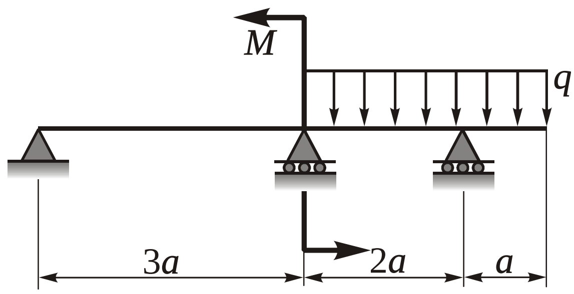
3.



Given: l= 4 *m*, cross-section – channel №14.

Aim: calculate critical force.

4.



Given: M=20 *kNm*, q=20 *kN/m*, a=1 *m*.

Aim: draw the graphs $Q_z(x), M_y(x)$.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

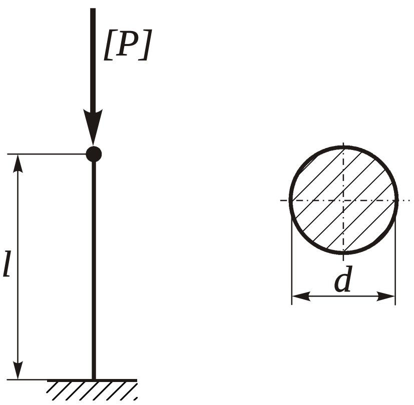
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 48

1. Dynamic factor formula (proof). General assumptions.
2. General characteristics of cycle of loading.

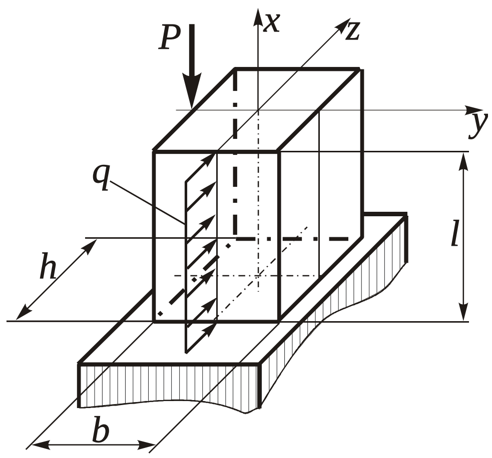
3.



Given: d=8 *cm*, l=3 *m*, $[s]_c = 160$ *MPa*.

Aim: calculate allowable compressive force.

4.



Given: q=20 *kNm*, P=20 *kN*, h=8 *cm*, b=4 *cm*.

Aim: draw the graph of stress distribution in critical section, calculate maximum stresses.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3**, 21 November, 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

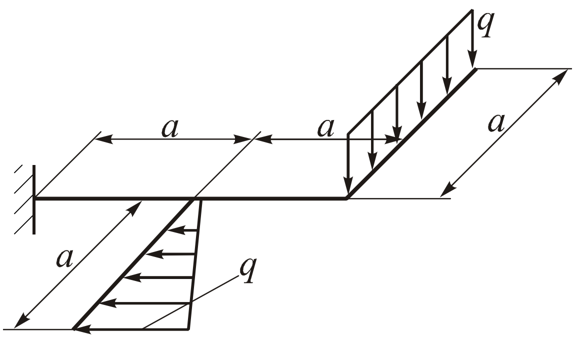
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 49

1. Euler formula proof. Limitations of its application.
2. Assumptions in proof of Laplace formula.

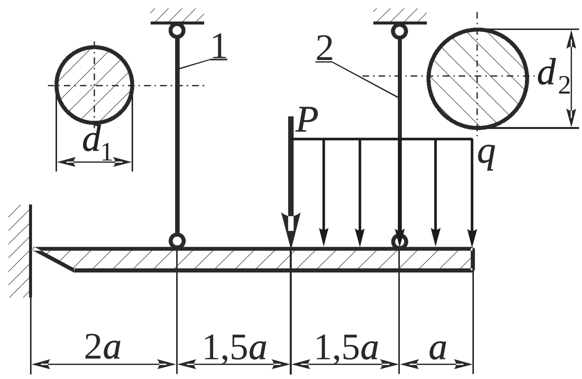
3.



Given: q=10 *kN/m*, a=3 *m*, cross-section – rectangle (h=10 *cm*, b=5 *cm*), $[s] = 160$ *MPa*.

Aim: check strength of fourth portion.

4.



Given: $d_1 = 4$ *cm*, $d_2 = 6$ *cm*, $l_1 = l_2 = 4$ *m*, $q = 10$ *kN/m*, $P = 10$ *kN*, $a = 1$ *m*, $s_y = 200$ *MPa*, $n = 2$.

Aim: check load-carrying ability of the rod system.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

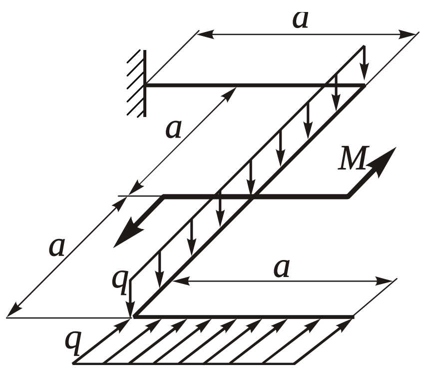
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 50

1. Diagram of critical stresses in buckling problem. Euler and Yasinski formulae for critical stresses..
2. Conditions of rational Vereschagin method application.

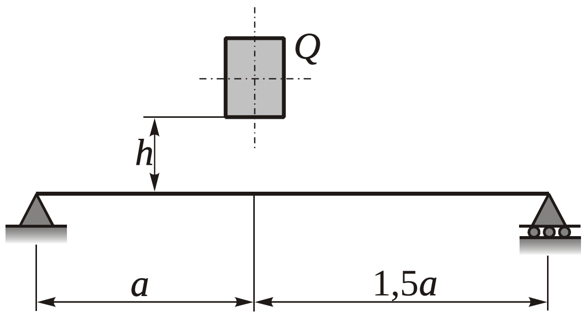
3.



Given: a=2 m, $q=10$ kN/m, M=10 kNm, $[s]=160$ MPa.

Aim: determine diameter of round section at fourth section.

4.



Given: $h=1$ cm, $Q=100$ N, a=1 m, $[s]=200$ MPa.

Aim: check dynamic strength of a beam.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

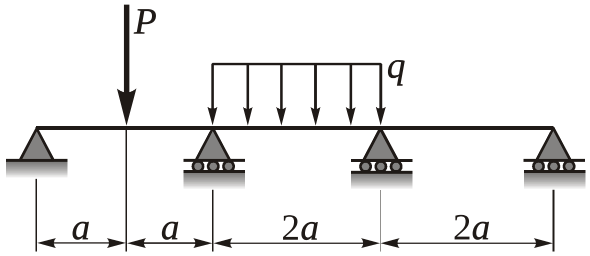
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 51

1. Force method of frame statical indeterminacy opening (the example).
2. Eccentric tension compression as important particularity of combined loading. Finding the critical point.

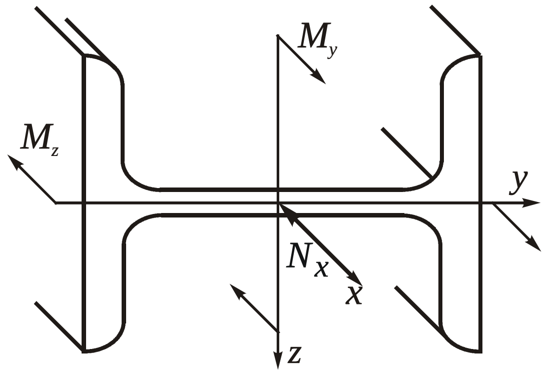
3.



Given: a=1 *m*, P=10 *kN*, $q = 20$ *kN/m*.

Aim: design the graphs $Q_z(x), M_y(x)$. Use three moment equations to open statical indeterminacy.

4.



Check strength of the section (I-beam №18). $M_y = 10$ *kNm*, $M_z = 20$ *kNm*, $N_x = 30$ *kN*, $[s] = 160$ *MPa*.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

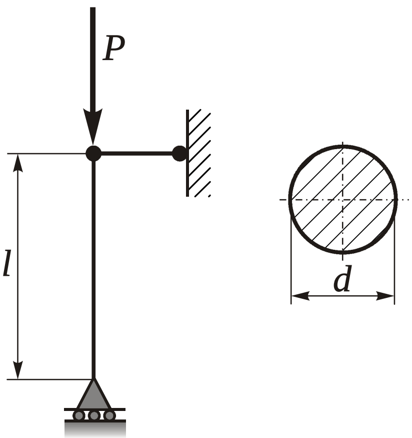
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 52

1. Third strength theory (theory of maximum shear stresses). Proof of strength condition for principal planes and planes of general position.
2. Oblique bending deformation. The method of critical points determination. Condition of strength.

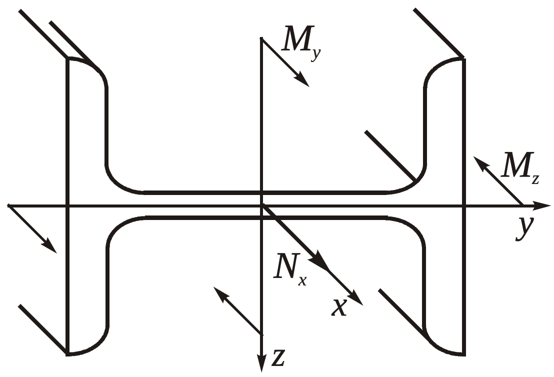
3.



Given: l=2 *m*, P=20 *kN*, $[s]_c = 160$ *MPa*.

Aim: calculate diameter of the post *d*.

4.



Check strength of the section (I-beam №18), $M_y = 10$ *kNm*, $M_z = 20$ *kNm*, $N_x = 30$ *kN*, $[s] = 160$ MPa

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

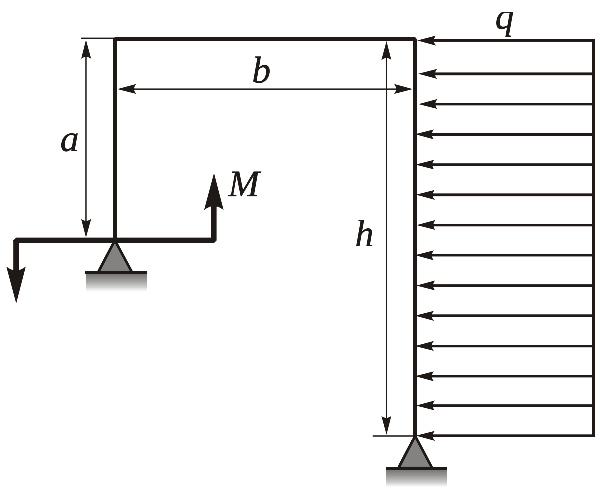
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 53

1. Von Mises strength theory. Proof of strength condition for principal planes and planes of general position.
2. Eccentric tension-compression. Description and method of critical point finding.

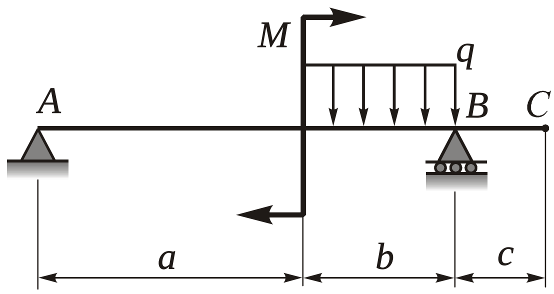
3.



Given: a=1 *m*, b=2 *m*, h=2 *m*, q=20 *kN/m*, M=20 *kNm*.

Aim: design the graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$.

4.



Given: a=3 *m*, b=2 *m*, c=1 *m*, M=20 *kNm*, q=10 *kN/m*, EI=const.

Aim: calculate vertical displacement of C-point.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

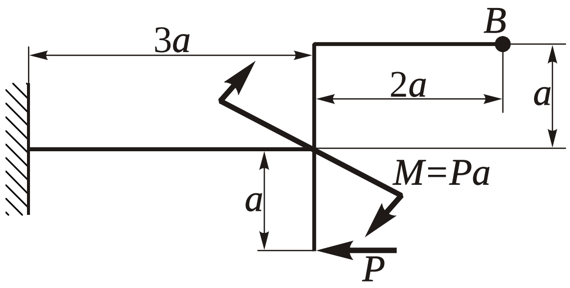
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 54

1. Stress analysis in buckling using stress reduction factor. Condition of stability. Types of problems which are solved using it.
2. Equation of three moments (formula and description of components).

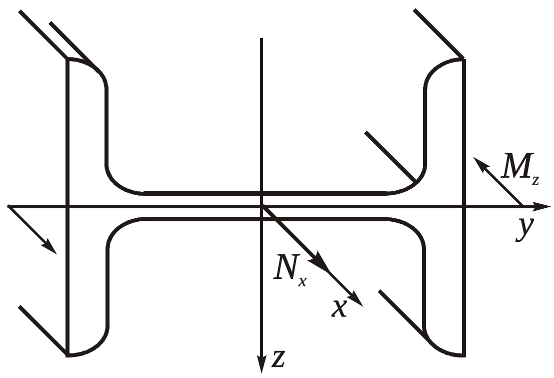
3.



Given: a=1 m, P=20 kN, EI=const.

Aim: calculate angle of rotation in B-section.

4.



Find neutral axis position in the section (I-beam №16). $M_z = 10$ kNm, $N_x = 10$ kN. Check the strength if $[s] = 150$ MPa.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

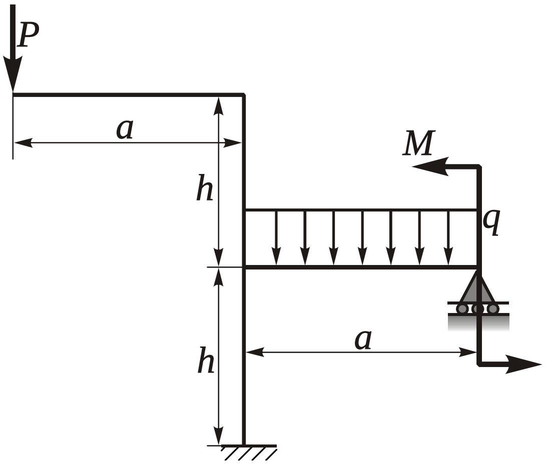
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 55

1. Laplace formula (proof).
2. General characteristics of cycle of periodical loading.

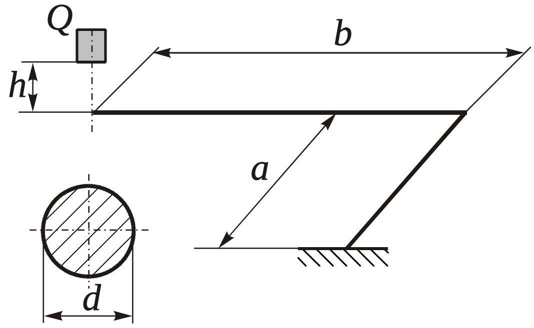
3.



Given: a=1 m, h = 2 m, q=20 kN/m, P=10 kN, M=40 kNm.

Aim: design the graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$.

4.



Given: a=1 m, b=2 m, Q=10 kN, h=0,02 m, d=5 cm.

Aim: calculate $s_{\max dyn}$.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

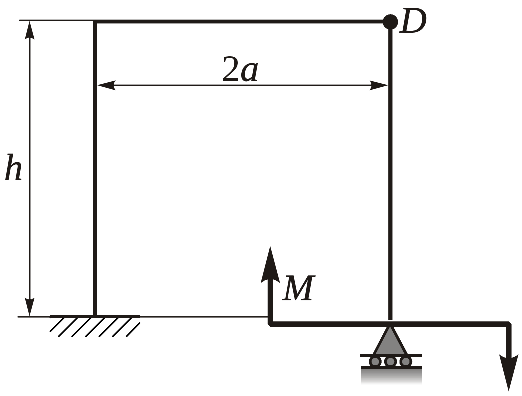
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 56

1. Generalized forces and displacements. Reciprocal theorems.
2. Influence of different boundary conditions on critical force.

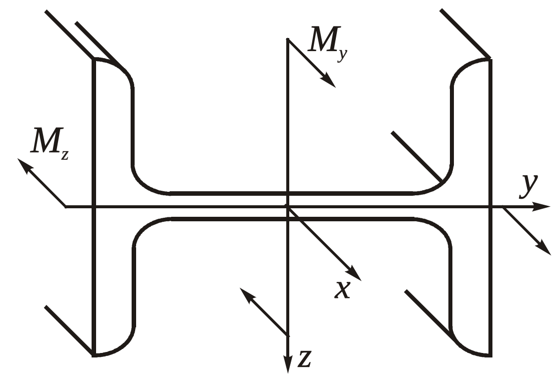
3.



<u>Given:</u> *a=1 m, h=2 m, M=20 kNm.*

<u>Aim:</u> calculate angle of rotation in *D*-point of statically indeterminate frame.

4.



Check strength of the section (I-beam №18).

$M_y = 10$ kNm, $M_z = 20$ kNm, $[s] = 160$ MPa

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

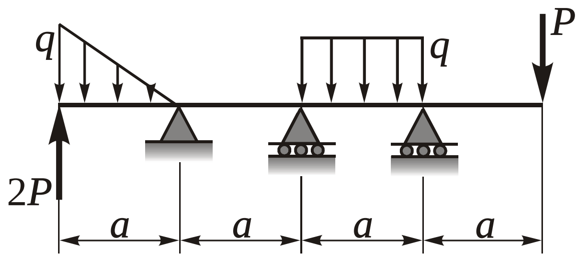
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 57

1. Reciprocal theorems (proof).
2. Fatigue strength diagram (description of the method of its design).

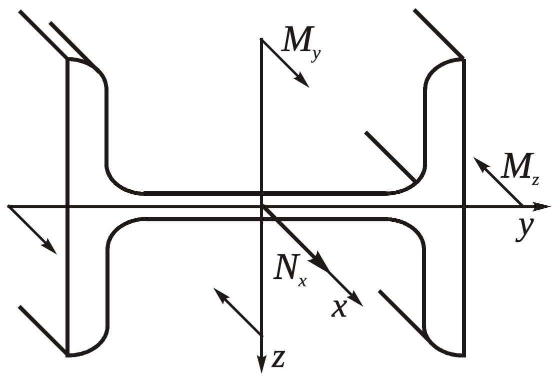
3.



Given: *a=1 m, P=10 kN, q=30 kN/m.*

Aim: design the graphs $Q_z(x), M_y(x)$.

4.



Check strength of the section (I-beam №18).

$M_y = 10 \; kNm,\; M_z = 20 \; kNm,\; N_x = 30 \; kN,$

$[s] = 160 \; MPa$

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

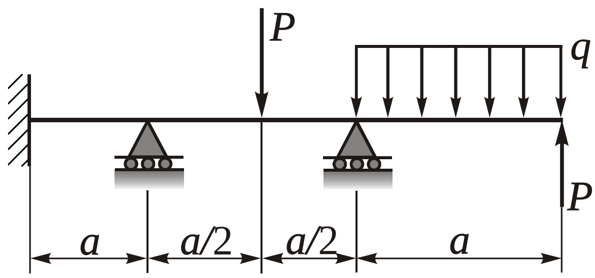
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 58

1. Mohr’s integral (proof).
2. Essence of material fatigue failure.

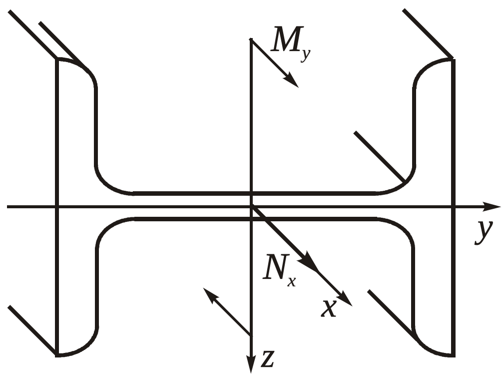
3.



Given: *a=2 m, q=4 kN/m, P=10 kN.*

Aim: design the graphs Q_z, M_y.

4.



Find position of cross-section neutral axis (I-beam №16) and check its strength. $M_y = 10\ kNm$, $N_x = 10\ kN$.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

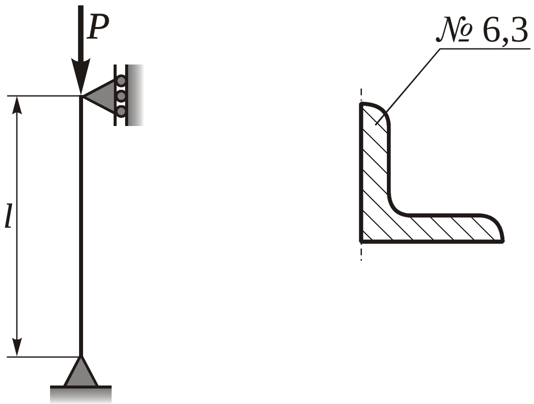
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 59

1. Vereschagin’s formula (proof).
2. Graphical determination of safety factor in fatigue.

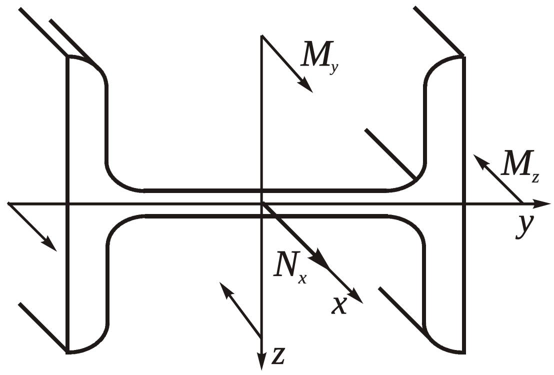
3.



Given: *l=2 m*, ∟*№6,3(4)*, *material steel Cm3*, $[s] = 160$ *MPa.*

Aim: calculate [*P*].

4.



Find position of cross-section neutral axis (I-beam №16) and check its strength. $M_z = 10$ *kNm*, $N_x = 10$ *kN*, $M_y = 20$ *kNm*.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

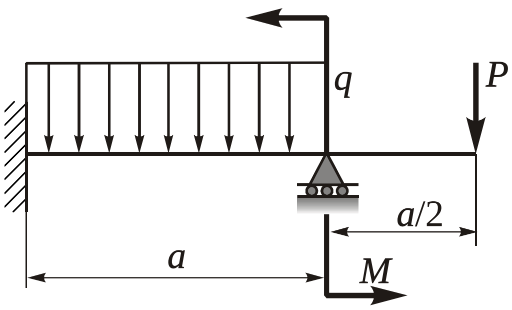
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 60

1. Force method. Proof of canonical equation.
2. Limitations on Yasinsky formula application.

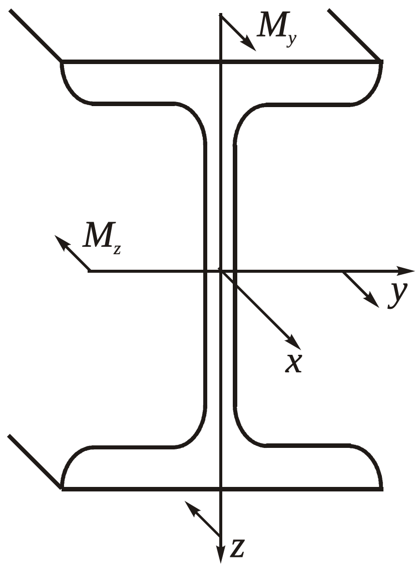
3.



Given: $a=3\ m$, $q=30\ kN/m$, $M=10\ kNm$, $P=10\ kN$, $[s]=160\ MPa$.

Aim: design the graphs Q_z and M_y and calculate diameter of round section. To open statical indeterminacy use the method of sections.

4.



Check the cross-section strength (I-beam №16), $M_y = 30\ kNm$, $M_z = 10\ kNm$, $[s] = 160\ MPa$

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

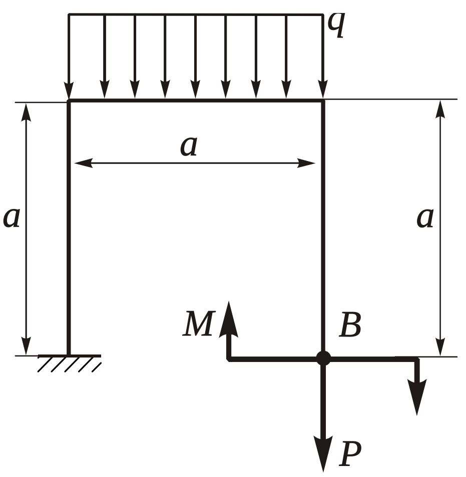
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

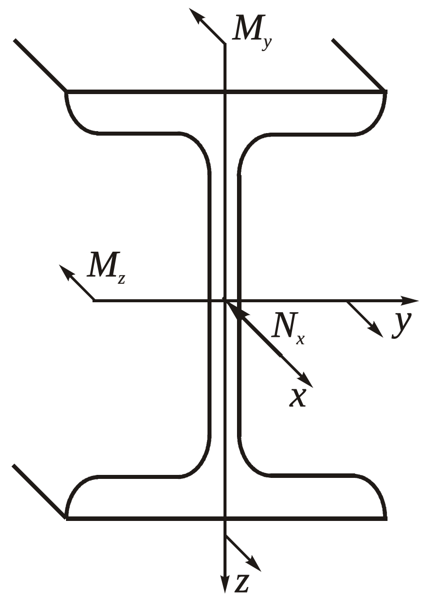
Examination card № 61

1. Multispan beams, Proof of three moment equation.
2. Determination of generalized force concept.

3.



4.



<u>Given:</u> *a=1 m, q=30 kN/m , M=10 kNm, P*=10 *kN*, *EI = const*.

<u>Aim:</u> calculate horizontal displacement of *B*-point.

Check the cross-section strength (I-beam №16). $N_x = 50kN$, $M_y = 30$ *kNm*, $M_z = 10$ *kNm*, $[s] = 160$ *MPa*

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

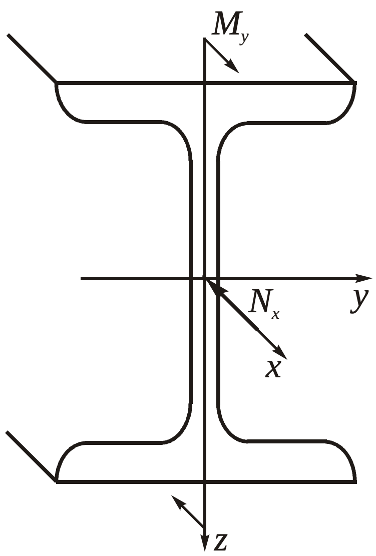
National aerospace university "Kharkiv Aviation Institute"

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **"Mechanics of materials"**

Examination card № 62

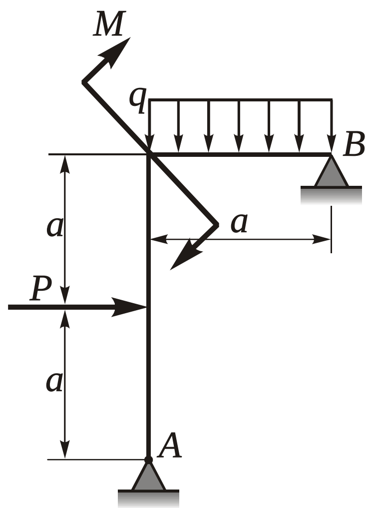
1. Experimental study of fatigue failure. Vohler's curve. Fatigue limit experimental determination.
2. Concept of stress reduction factor in stability problem. Factors which influence stress reduction factor.

3.



Find position of cross-section neutral axis (I-beam №18). $M_y = 10\ kNm,\ N_x = 10\ kN$

4.



Given: *a=2 m, M=*30 *kNm, P=20 kN, q=4 kN/m.*

Aim: design the graphs N_x, Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

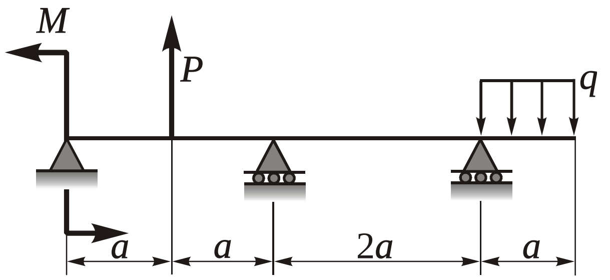
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 63

1. Three moment equation (proof).
2. How to determine statical deformation in dynamic factor formula.

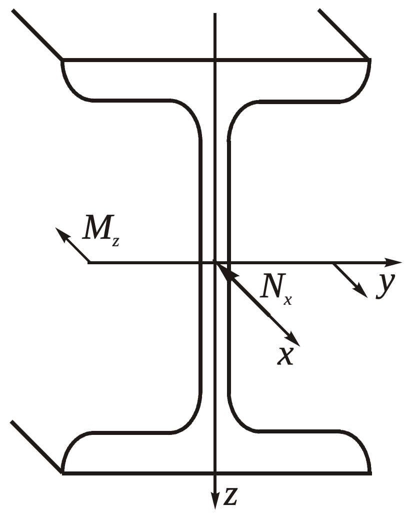
3.



Given: *a=1 m, q=2 kN/m, M=*20 *kNm, P=8 kN,* $EI_y = const$.

Aim: design the graphs Q_z, M_y.

4.



Check the strength of cross-section (I-beam №18), if $M_z = 10\ kNm,\ N_x = 10\ kN$

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

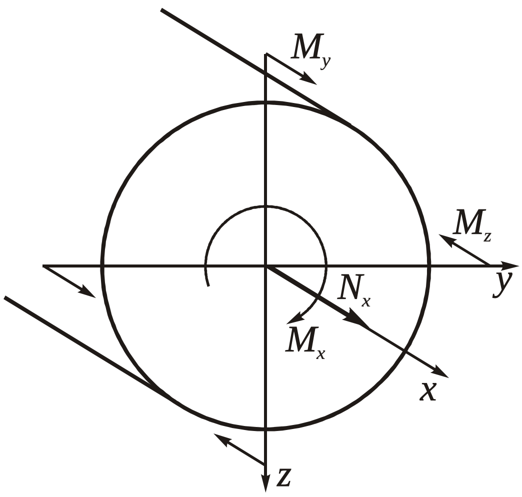
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 64

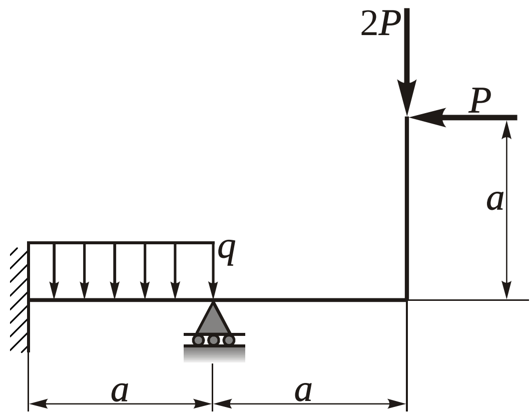
1. Graphical calculation of factor of safety in fatigue using fatigue strength diagram.
2. Three moment equation. Description of its components.

3.



Calculate cross-ectional diameter, if $M_x = 10$ *kNm*, $M_y = 20$ *kNm*, $M_z = 30$ *kNm*, $[s] = 160$ *MPa*, $N_x = 40$ *kN*

4.



Given: *a=1 m, q=10 kN/m, P=10 kN.*

Aim: design the graphs N_x, Q_z, M_y, using three moment equation to open statical indeterminacy.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

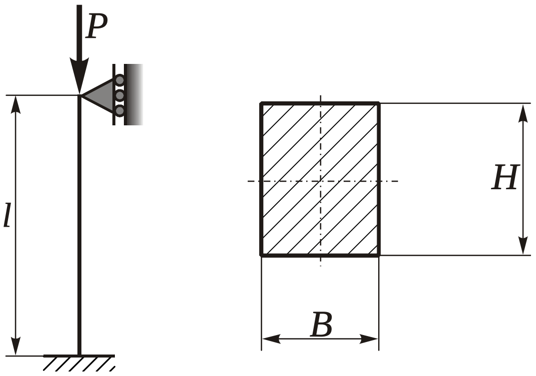
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 65

1. Laplace formula (proof).
2. Conditions of rational use of Vereschagin’s formula.

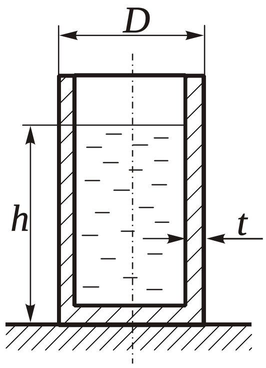
3.



Given: $l=3\ m,\ B=8\times10^{-2}\ м,\ H=12\times10^{-2}\ м,$ $n_s=3$, *material – steel Cm3.*

Aim: calculate $P_{cr}, [P]$

4.



Given: $h=1\ m, D=0.8\ m,\ r=10^3\ kg/m^3,$ $[s]=100\ MPa.$

Aim: calculate thickness of cylindrical shell *t*.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

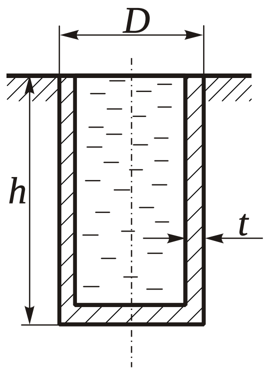
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc.   Branch of education: 1001   **Aerospace Engineering**   Semester ***IV***
Course   **“Mechanics of materials”**

Examination card № 66

1. Fatigue strength diagram, its design and features
2. Selection of basic and equivalent systems in force method (example).

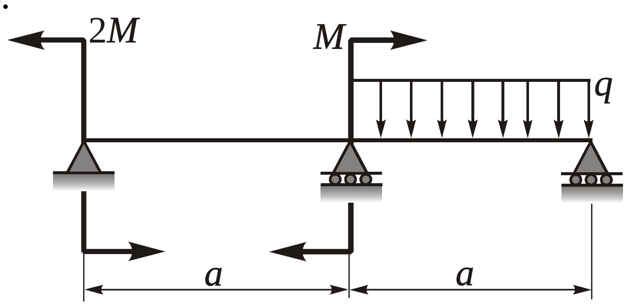
3.



Given: $h=1\ m,\ D=0.8\ m,\ r = 10^3\ kg/m^3,$
$[s] = 100\ MPa.$

Aim: calculate thickness of the shell t.

4.



Given: $a=2\ m,\ q=14\ kN/m,\ M=20\ kNm.$

Aim: design the graphs Q_z and M_y.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,**   21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner   **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

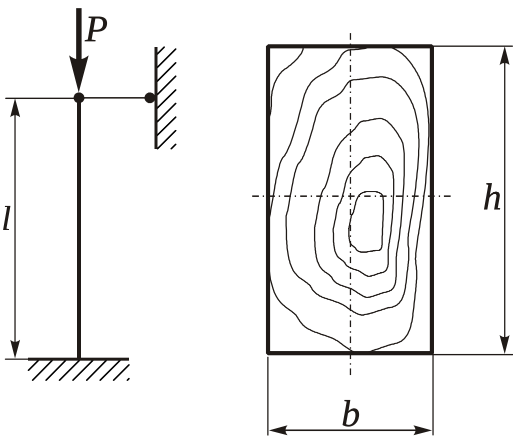
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 67

1. Proof of Euler formula for critical force.
2. Fatigue limit and its experimental determination.

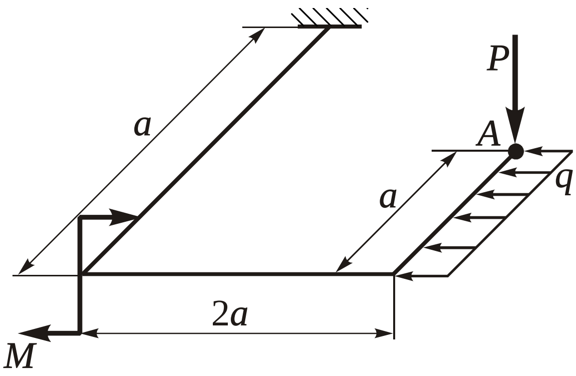
3.



Given: $l=2\ m$, $h=2b$, $b=10\times10^{-2}\ m$, $P=15\ kN$,
$[s]=10\ MPa$, *material of the post – pine.*

Aim: check the stability of the post.

4.



Given: $a=1\ m$, $q=2\ kN/m$, $P=20\ kN$, $M=20\ kNm$.
$[s]=140\ MPa$, $E=2\times10^{5}\ MPa$.

Aim: calculate diameter of round cross-section in third portion.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

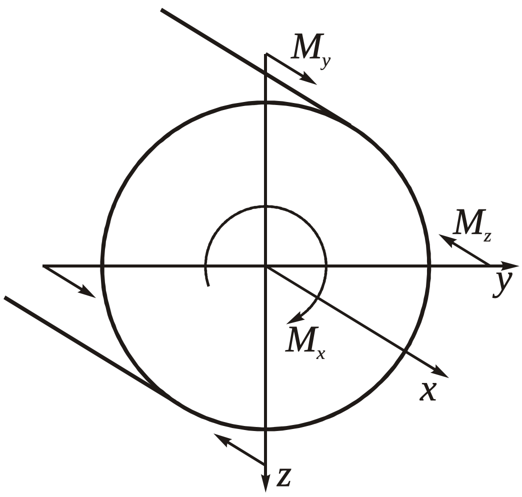
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 68

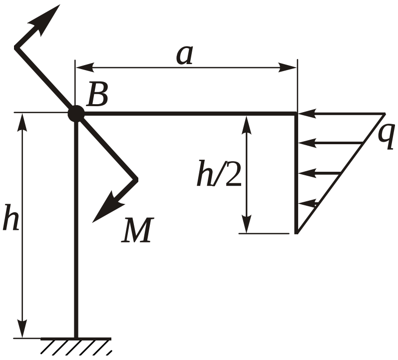
1. Influence of boundary conditions on critical force.
2. Concept of asymmetry factor. What cycle is the most dangerous?

3.



Calculate diametrer of round section. $M_x = 10$ *kNm*, $M_y = 20$ *kNm*, $M_z = 30$ *kNm*, $[s] = 160$ *MPa*

4.



Given: *h=2 m, a=2 m, q=30 kN/m, M=*20 *kNm*, $EI_{n.a.}$ *= const.*

Aim: calculate angle of rotation of *B*-section using Vereschagin’s methot.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

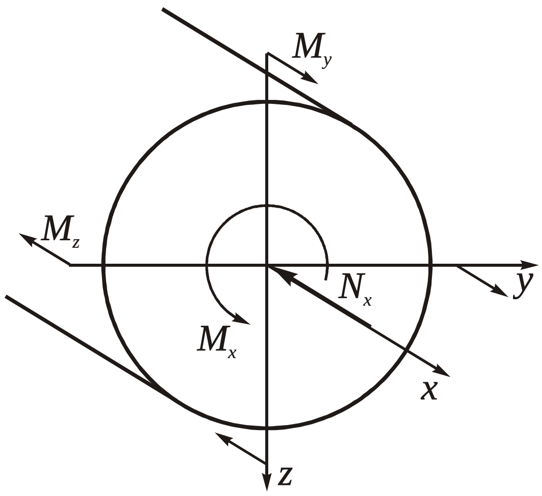
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 69

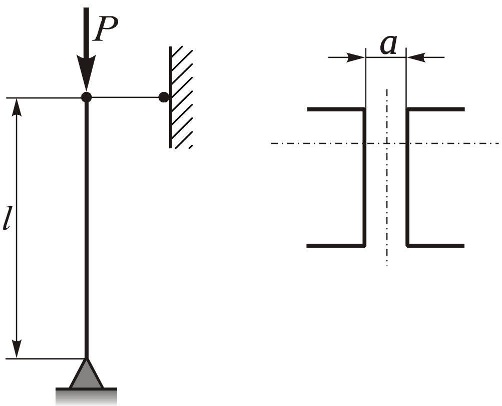
1. Diagram of critical stresses in buckling. Yasinski formula, its description and limitations on application.
2. Selection of basic and equivalent systems in force method (example).

3.



Find position of cross-sectional critical point if $M_x = 10$ *kNm*, $M_y = 20$ *kNm*, $M_z = 40$ *kNm*, $[s] = 160$ *MPa*, $N_x = 30$ *kN*

4.



<u>Given:</u> *l=3 m, cross-section – two channels №20,* $K = 2.5$, $a = 4 \times 10^{-2}$ *m, material – steel Cm3.*

<u>Aim:</u> calculate $P_{cr}, [P]$

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

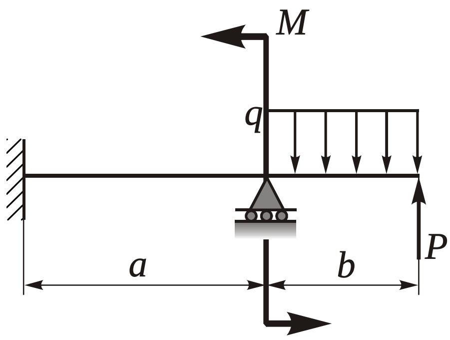
Degree B. Sc.   Branch of education: 1001 **Aerospace Engineering**   Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 70

1. Stress analysis in buckling: description of two possible methods.
2. How to improve fatigue strength?

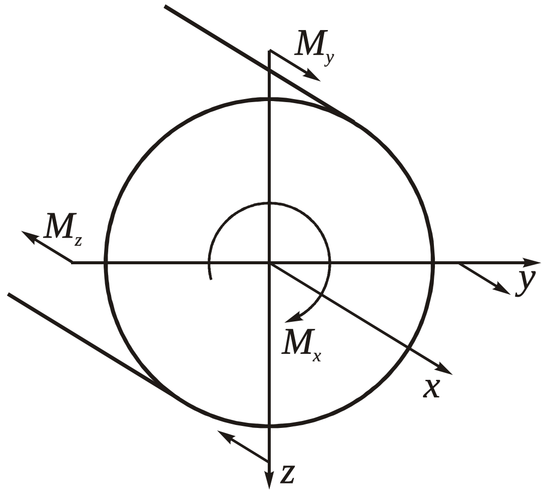
3.



Given: *a=4 m, b=2 m, q=10 kN/m, M*=20 *kNm, P*=10 *kN*.

Aim: design the graphs Q_z, M_y.

4.



Find position of cross-sectional critical point and calculate the diameter if $M_x = 10$ kNm, $M_y = 20$ kNm, $M_z = 40$ kNm, $[s] = 160$ MPa

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

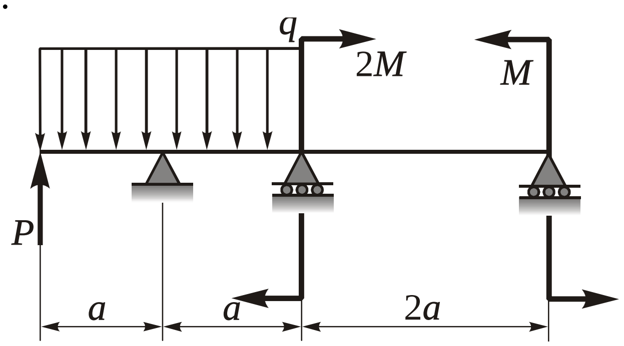
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 71

1. Laplace formula (proof).
2. Theoretical and effective stress concentration factors.

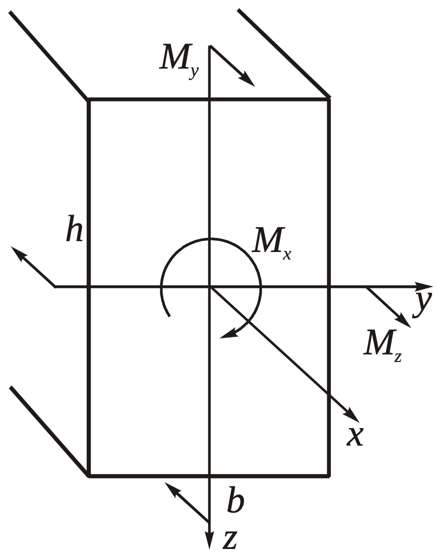
3.



<u>Given:</u> *a=1.5 m, q=2 kN/m, M=6 kNm, P*=10 *kN*, $EI_y = const$.

<u>Aim:</u> design the graphs of internal forces.

4.



Calculate cross-sectional dimensions if $h/b = 2$, $[s] = 160$ *MPa*, $M_y = 40$ *kNm*, $M_z = 20$ *kNm*, $M_x = 40$ *kNm*.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

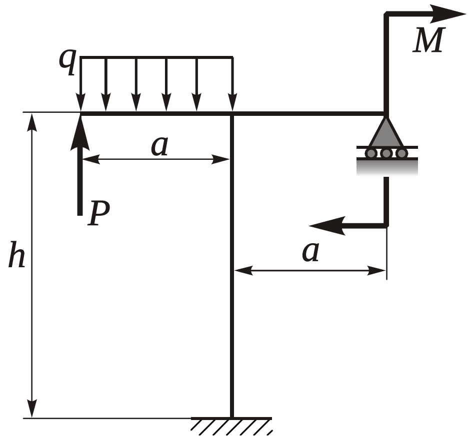
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 72

1. Laplace formula (proof).
2. Concept of stress concentration factor.

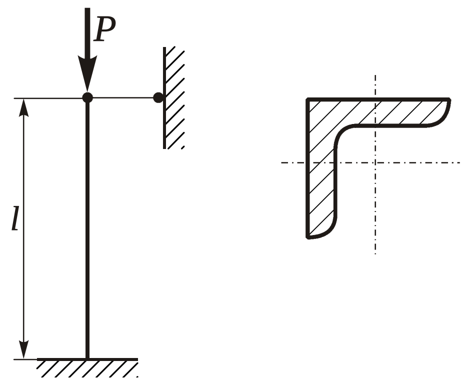
3.



Given: *a=1 m, h=2 m, q=30 kN/m, M=20 kNm, P=10 kN.*

Aim: design the graphs N_x, Q_z, M_y.

4.



Given: *l=4 m, P=20 kN,* $[s\ ] = 160$ *MPa, material – steel Cm3.*

Aim: determine number of equileg angle profile.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

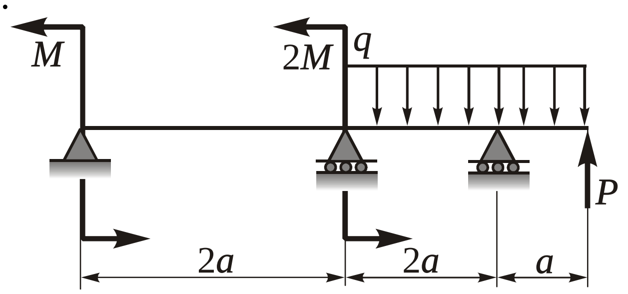
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 73

1. General case of combined loading of round section. Critical points, condition of strength, solution of design problem.
2. Complementary equation for calculating acting stresses in thin-walled shell.

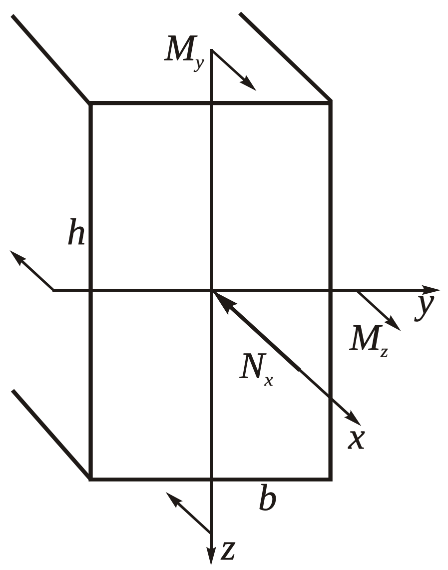
3.



Given: *a=1 m, q=20 kN/m, M=10 kNm, P=30kN.*

Aim: design the graphs Q_z and M_y.

4.



Calculate cross-sectional dimensions if $h/b = 2$, $[s] = 160$ *MPa*, $M_y = 40$ *kNm*, $M_z = 20$ *kNm*, $N_x = 10$ *kN*

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

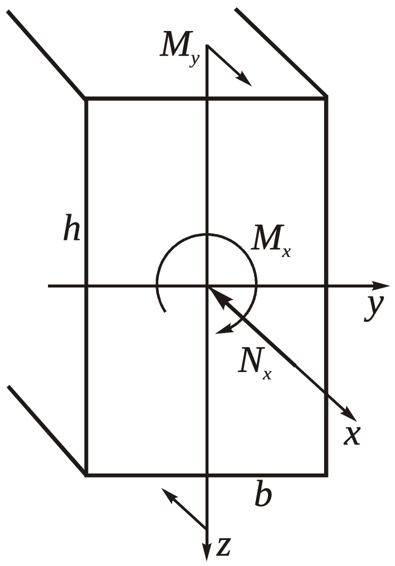
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 74

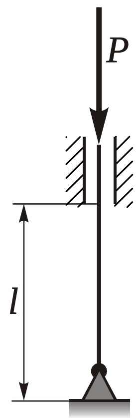
1. General case of combined loading of rectangle cross-section.Critical points, condition of strength, solution of design problem.
2. Difference between concepts “stress concentrator” and “stress concentration”.

3.



Calculate cross-sectional dimensions $h/b = 2$, $[s] = 160$ *MPa*, $M_y = 40$ *kNm*, $M_x = 20$ *kNm*, $N_x = 10$ *kN*

4.



Given: *l=2 m, P=40 kN,* $[s]_c = 160$ *MPa, material – steel Cm5.*

Aim: determine number of I-beam sections.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

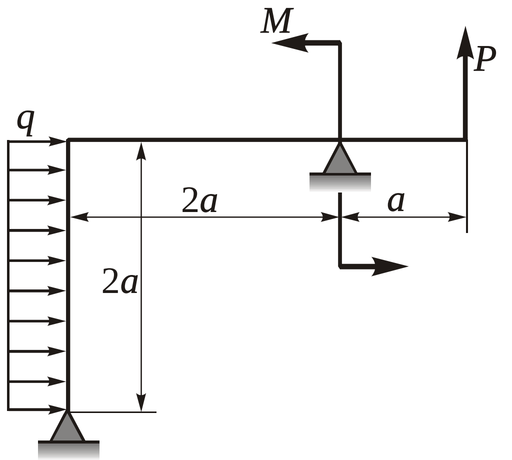
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 75

1. Second strength theory: condition of strength for principal stresses.
2. Assumptions to applicability of superposition principle.

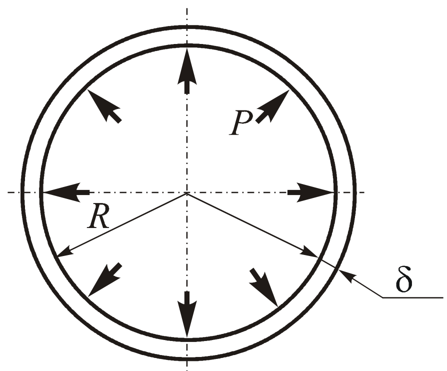
3.



<u>Given:</u> *a=1 m, q=2 kN/m, M=*20 *kNm, P=30 kN, EI=const.*

<u>Aim:</u> design the graphs N, Q_z, M_y.

4.



<u>Given:</u> *R=0.2 m, P=*10 *MPa,* $[s\ ] = 150$ *MPa.*

<u>Aim:</u> determine thickness of the shell d .

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

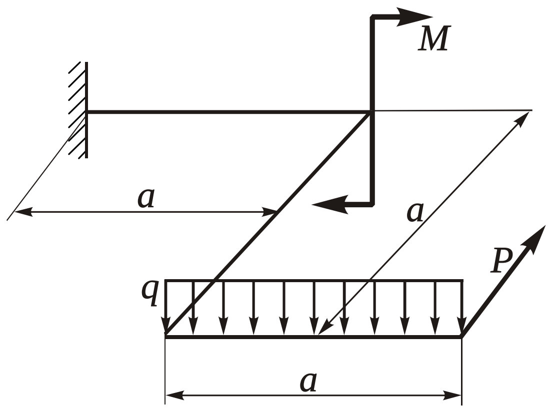
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 76

1. First strength theory (theory of maximum normal stresses): condition of strength for principal stresses.
2. Assumptions in proof of Laplace formula.

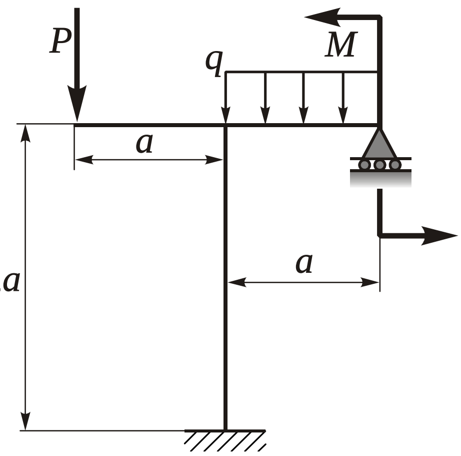
3.



Given: a*=1 m,* $[s]=160$ *MPa,* $P=10$ *kN,* *q=10 kN/m, M=*20 *kNm.*

Aim: determine diameter of the third portion.

4.



Given: *l=1.5 m, I-beam section №18, material – steel Cm3,* $q=10$ *kN/m, P=5 kN, M=20 kNm, a=1 m.*

Aim: design the graphs N_x, Q_z, M_y and check its strength if $[s]=160$ MPa.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

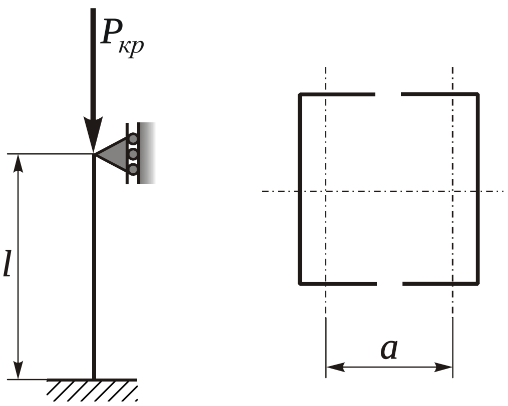
Degree B. Sc.   Branch of education: 1001 **Aerospace Engineering**   Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 77

1. Laplace formula (proof).
2. Nominal and local stresses. Concepts of theoretical stress concentration factor.

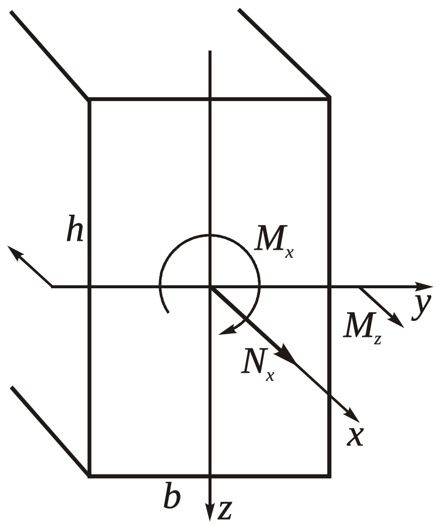
3.



Given: *l*=4 *m, two channels №*24*, material – steel 45.*

Aim: determine optimal distance *a* from condition of equistability and calculate critical force P_{cr}.

4.



Determine cross-sectional dimensions if $h/b = 2$, $[s] = 160$ *MPa*, $M_z = 40$ *kNm*, $M_x = 20$ *kNm*, $N_x = 10$ *kN*

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

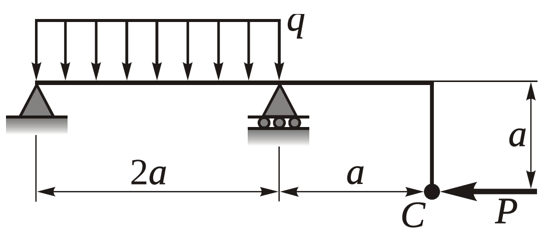
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 78

1. Stress analysis of cylindrical pressure vessel under hydraulic pressure. Stress distribution along the height, critical section, condition of strength.
2. Limitations on Laplace formula application. Graph of critical stresses.

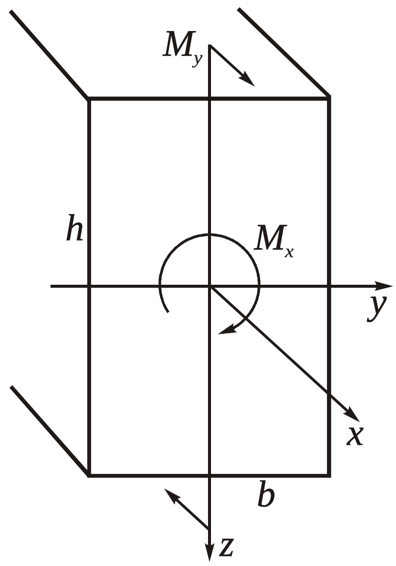
3.



Given: *a=1 m, q=6 kN/m, P=8 kN, cross-section – round, d=0.1 m,* $E = 2\times10^5$ *MPa*.

Aim: calculate horizontal displacement of *C*-point.

4.



Calculate cross-sectional dimensions if $h/b = 2$, $[s] = 160$ *MPa*, $M_y = 40$ *kNm*, $M_x = 20$ *kNm*

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

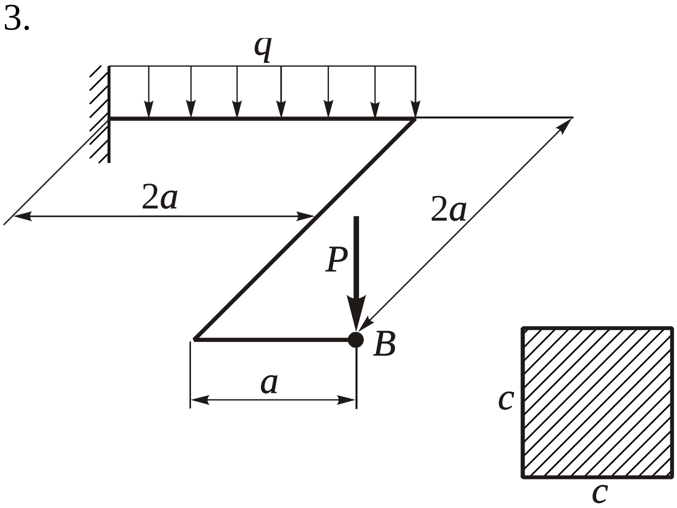
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 79

1. Third strength theory (theory of maximum shear stresses). Condition of strength for principal and arbitrary planes.
2. Concept of critical force.

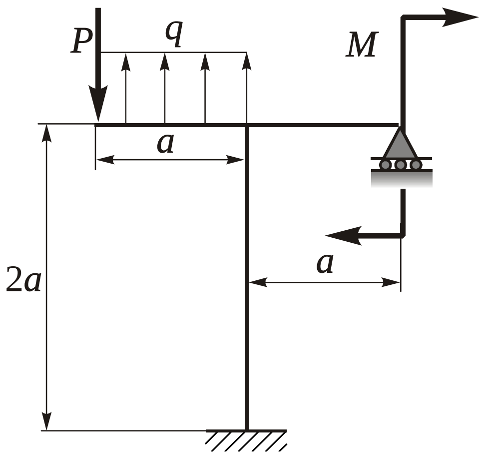
3.



<u>Given:</u> *a=1 m, q=10 kN/m, P=10 kN,*
$c = 8 \times 10^{-2}$ *m (cross-section – square),*
$G = 8 \times 10^{4}$ *MPa*, $E = 2 \times 10^{5}$ *MPa*,
$[s] = 160$ *MPa.*

<u>Aim:</u> check strength of third portion.

4.



<u>Given:</u> *a=1 m, P=10 kN, M=6 kNm, q=10 kN/m.*

<u>Aim:</u> design the graphs N_x, Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

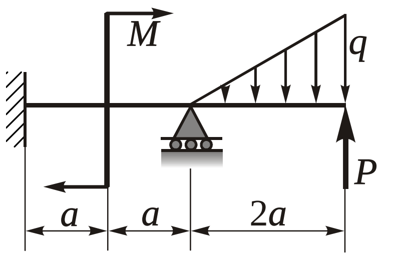
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 80

1. Eccentric tension-compression. Calculation of acting stresses in cross-section, critical point, condition of strength, position of neutral axis.
2. Assumptions in proof of dynamic factor formula.

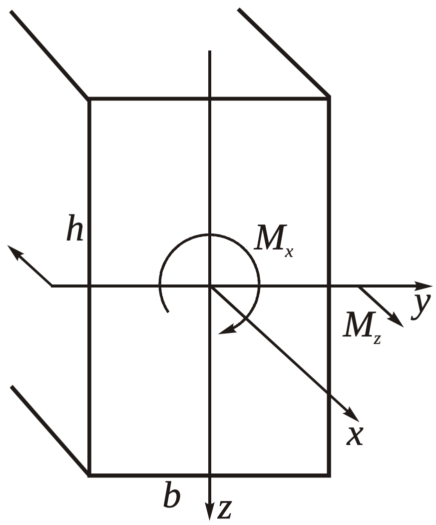
3.



Given: a=2 m, q=30 kN/m, M=25 kNm, P=10 kN.

Aim: design the graphs Q_z and M_y.

4.



Calculate cross-sectional dimensions, if $h/b = 2$, $[s] = 160\ MPa$, $M_z = 40\ kNm$, $M_x = 20\ kNm$

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

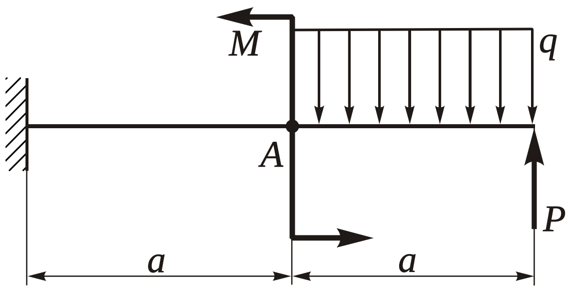
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 81

1. Stress analysis under dymamic loading. Proof of the formula for dynamic factor.
2. Basic and equivalent systems in force method. Geometrical essence of canonical equations.

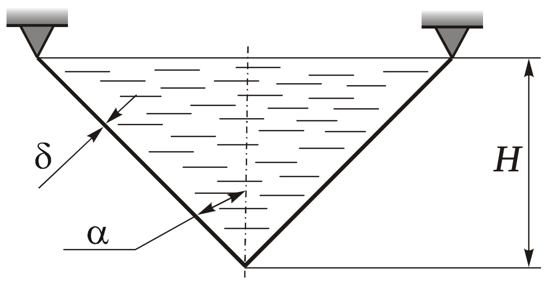
3.



<u>Given:</u> a=2 m, q=30 kN/m, M=10 kNm, P=10 kN, EI=const.

<u>Aim:</u> calculate vertical displacement of A-section.

4.



<u>Given:</u> $H=1\ m,\ a = 30^\circ,\ d = 1\times10^{-2}\ m,$
$r = 10^3\ kg/m^3.$

<u>Aim:</u> design the graphs of meridional stress s_m distribution along vertical axis of the shell.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

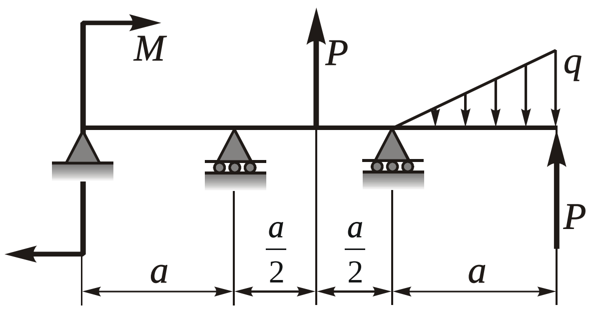
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 82

1. Stress analysis in buckling using stress reduction factor. Condition of stability, problems which are solved by it.
2. Description of the method of opening statical indeterminacy of multispan beams.

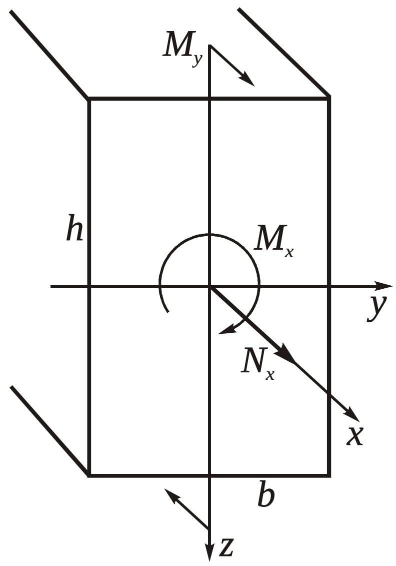
3.



Given: a=3 *m*, q=20 *kN/m*, P=10 *kN*, M=20 *kNm*.

Aim: design the graphs Q_z and M_y ..

4.



Calculate cross-sectional dimensions if $h/b=2$, $[s]=160$ *MPa*, $M_y=40$ *kNm*, $M_x=20$ *kNm*, N_x*=30kN*.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

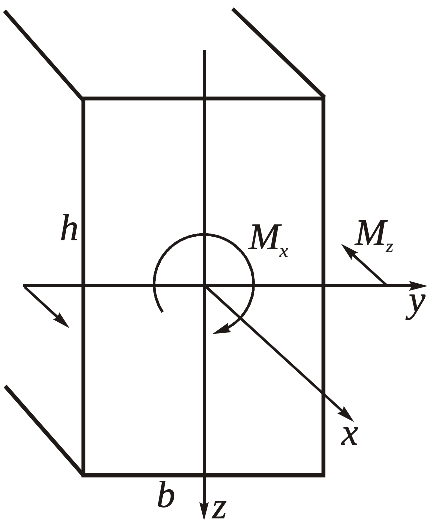
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 83

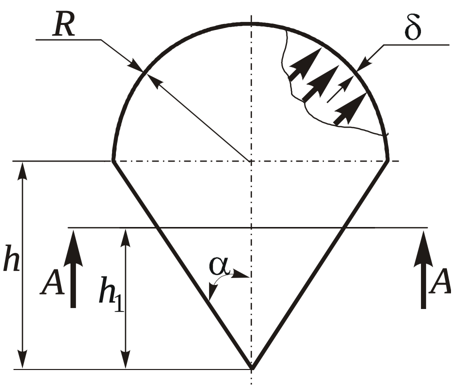
1. General case of combined loading of a round section. Critical point, condition of strength.
2. Limitations on Euler's formula application.

3.



Calculate cross-sectional dimensions if $h/b=2$, $[s]=160\ MPa,\ M_z=40\ kNm,\ M_x=20\ kNm$

4.



Given: R=0,5 *m*, P=30 *MPa*, $d=2\times10^{-2}\ m$, h=0,5 *m*, h_1=0,1 *m*, $a=45°$.

Aim: calculate acting stresses in A-A section of the conical shell.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

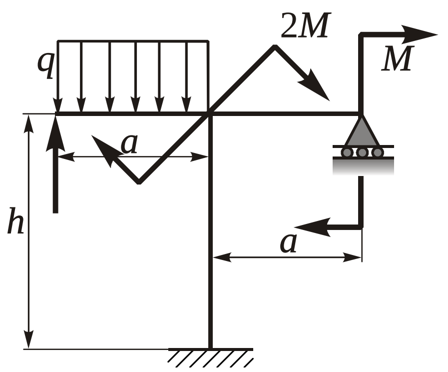
National aerospace university "Kharkiv Aviation Institute"

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **"Mechanics of materials"**

Examination card № 84

1. Experimental study of fatigue limit: test device, Vohler's curve, fatigue limit determination.
2. Allowable stress in stability and its calculation using stress reduction factor.

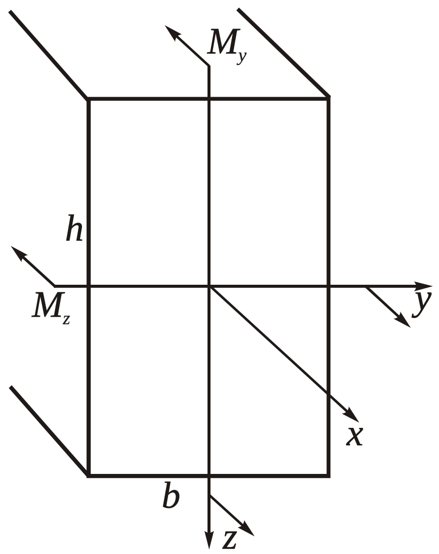
3.



Given: *a=1 m, h=2 m, q=20 kN/m, M=20 kNm, P=10 kN.*

Aim: design the graphs N_x, Q_z, M_y.

4.



Check the strength of cross-section if $[s]=160$ MPa, $M_y = 20$ *kNm*, $M_z = 40$ *kNm*, $h = 10^{-1}$ *m*, $b = 5 \cdot 10^{-2}$ *m.*

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

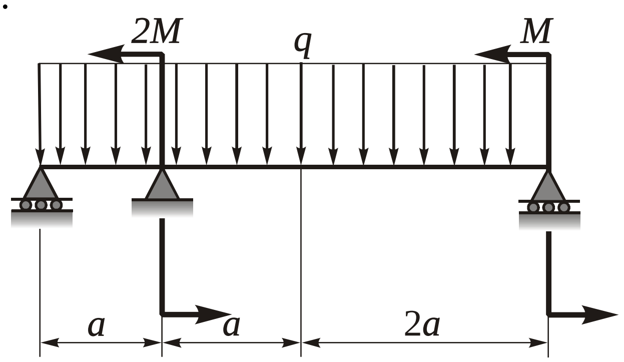
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 85

1. Proof of Euler’s formula.
2. Concepts of theoretical and effective stress-concentration factors.

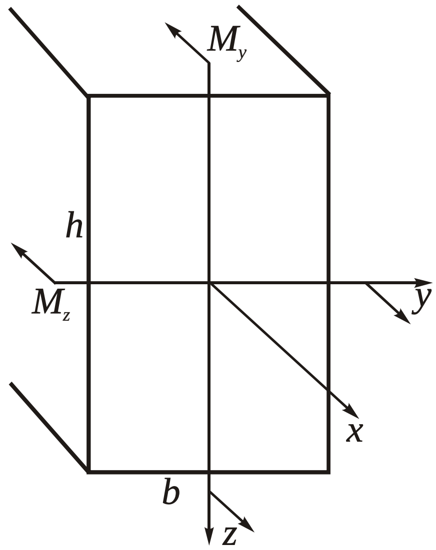
3.



Given: *a=1.5 m, q=2 kN/m, M=6 kNm*
$EI_y = const$.

Aim: design the graphs Q_z, M_y.

4.



Find position of cross-sectional neutral axis and check its strength if $[s] = 160\ MPa,\ M_y = 20\ kNm,$ $M_z = 40\ kNm,\ h = 10^{-1}\ m,\ b = 5 \cdot 10^{-2}\ m.$

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

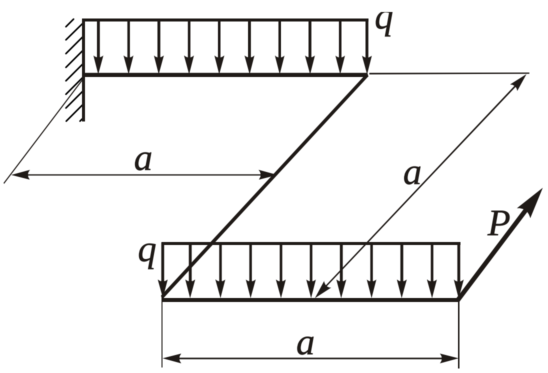
Degree B. Sc.   Branch of education: 1001 **Aerospace Engineering**   Semester ***IV***

Course   **“Mechanics of materials”**

Examination card № 86

1. General case of rectangle section combined loading. Critical points, conditions of strength.
2. Assumptions in Laplace formula proof.

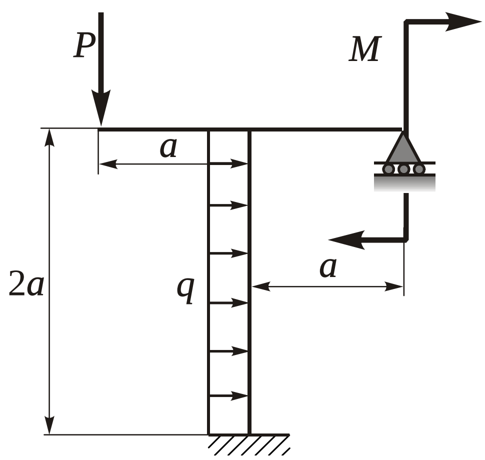
3.



Given: *a=1 m, P=20 kN, q=10 kN/m,* $[s]=160$ *MPa, h/b=2*

Aim: determine rectangle cross-section dimensions at third portion.

4.



Given: *a=1 m, P=10 kN, M=16 kNm, q=10 kN/m.*

Aim: design the graphs N_x, Q_z, M_y.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

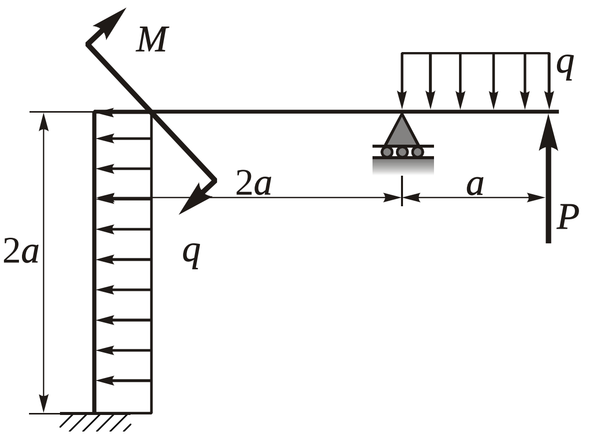
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 87

1. Von Mises strength theory: proof of condition of strength for principle and arbitrary planes.
2. Eccentric compression: description, critical point, condition of strength.

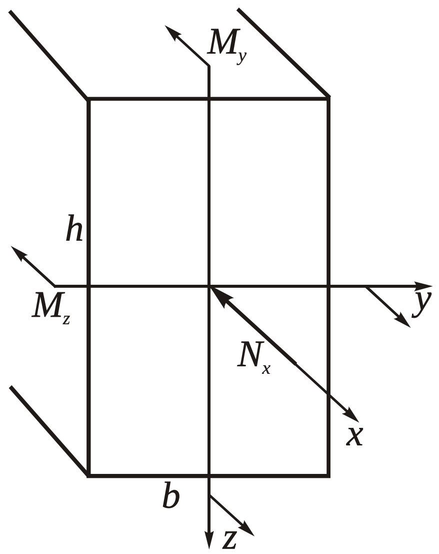
3.



<u>Given:</u> *a=1 m, P=10 kN, q=10 kN/m, M=10 kNm*

<u>Aim:</u> design the graphs N_x, Q_z, M_y

4.



Checkthe strength of cross-section if $[s]=160\ MPa,\quad M_y=20\quad kNm,\quad M_z=40\quad kNm,$ $h=10^{-1}\ m,\ b=5\cdot10^{-2}\ m,\ N_x=10\ kN$

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

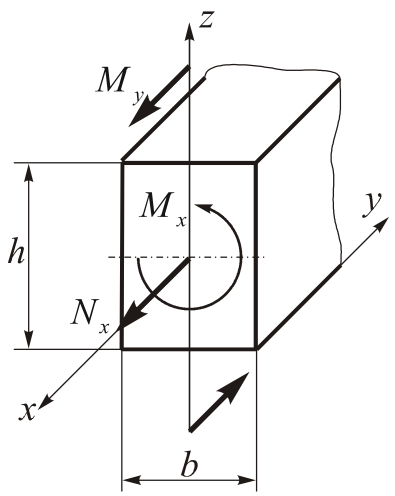
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 88

1. Third strength theory (theory of maximum shear stresses): determination and condition of strength.
2. Oblique bending: critical points and condition of strength. Graphical calculation of neutral axis position.

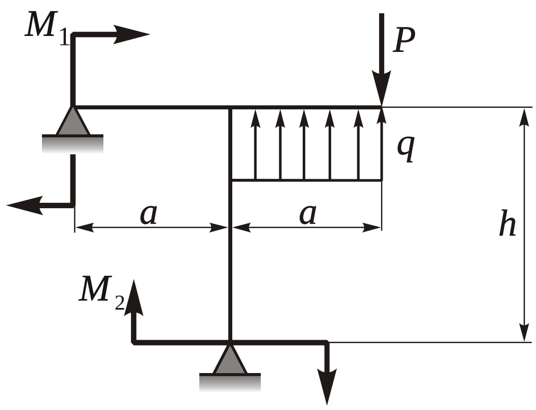
3.



Given: $M_x = 10\ kNm,\ M_y = 20\ kNm,$
$N_x = 10\ kN,\ [s] = 200\ MPa$, *h/b=2.*

Aim: calculate cross-section dimensions.

4.



Given: *a=1 m, h=2 m,* $M_1 = 10\ kNm,$
$M_2 = 20\ kNm,$ *q=10 kN/m, P=10 kN*

Aim: design the graphs N_x, Q_z, M_y

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

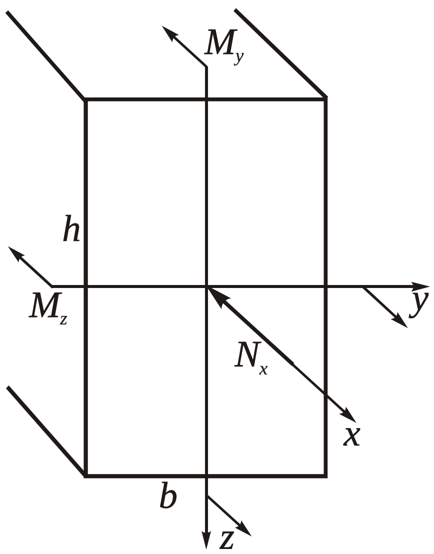
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 89

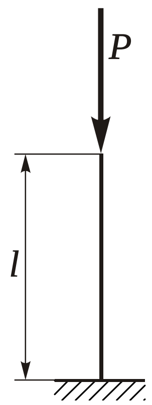
1. Force method for opening statical indeterminacy of frames.
2. Concepts of “oblique bending” and “eccentric tension” deformations.

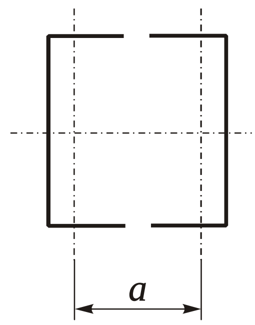
3.



Determine neutral axis position and check strength of the section if $[s]=160$ *MPa*, $M_y = 20$ *kNm*, $M_z = 40$ *kNm*, $h = 10^{-1}$ *m*, $b = 5\cdot 10^{-2}$ *m*, $N_x = 10$ *kN*

4.





Given: *l=3 m, two channels N20, material – steel 20.*

Aim: find optimal *a* distance from condition of equistability and calculate P_{cr}.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

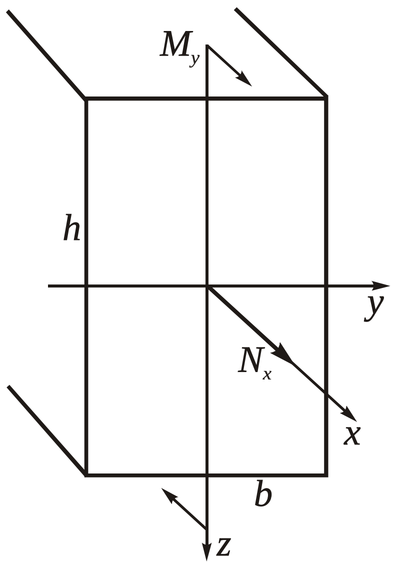
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials”**

Examination card № 90

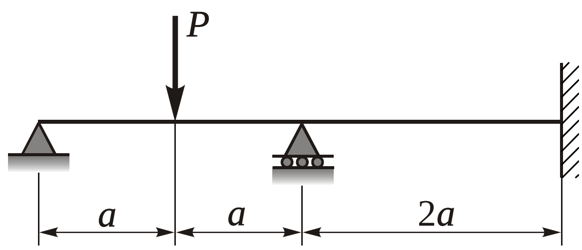
1. Third strength theory (theory of maximum shear stresses): finding equivalent stresses, condition of strength for principal stresses.
2. Oblique bending: finding critical points and condition of strength.

3.



Determine neutral axis position and check its strength if $[s]=160\ MPa,\ M_y=40\ kNm,\ h=10^{-1}\ m,\ b=5\cdot10^{-2}\ m,\ N_x=10\ kN$

4.



Given: P=10 kN, a=1 m.

Aim: design the graphs $Q_z(x), M_y(x)$ using three moment equation to open statical indeterminacy.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

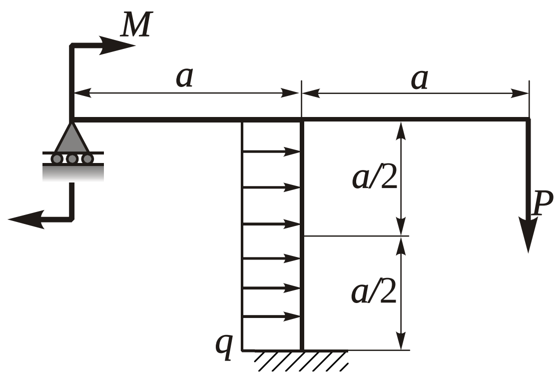
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 91

1. Reciprocal theorems (proof).
2. Selection of equivalent system and development of canonical equation in force method.

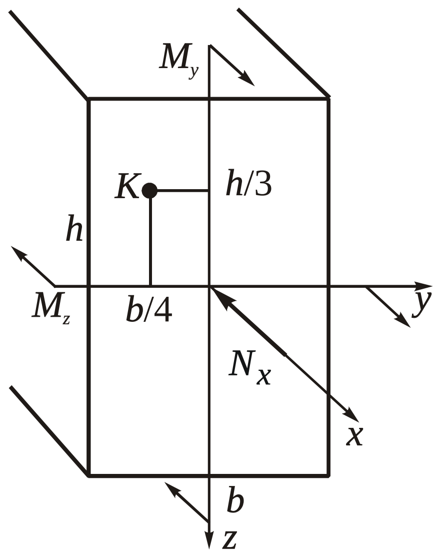
3.



Given: $q=10$ kN/m, $P=10$ kN, $M=10$ kNm, $a=2$ m.

Aim: design the graphs N_x, Q_z, M_y.

4.



Calculate acting stresses in K-point, if $h=10^{-1}$ m, $b=5\cdot10^{-2}$ m, $M_y=50$ kNm, $M_z=20$ kNm, $N_x=10$ kN, and estimate its stress state.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

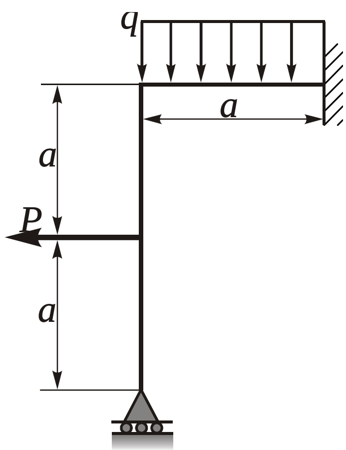
National aerospace university “Kharkiv Aviation Institute”

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **“Mechanics of materials”**

Examination card № 92

1. Proof of canonical equation of force method for singly statically indeterminate frame.
2. Limitations on Euler’s formula application.

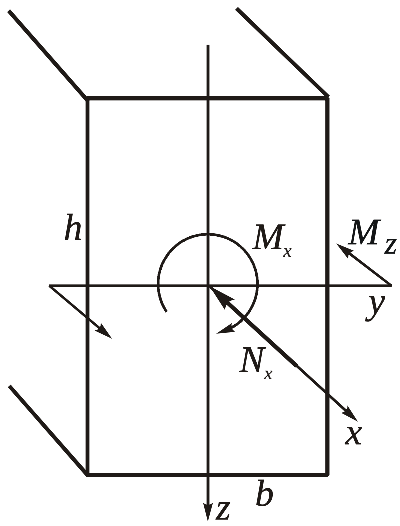
3.



Given: P=10 kN, q=10 kN/m, a=2 m.

Aim: design the graphs N_x, Q_z, M_y.

4.



Find critical points of the section and check its strength if $[s]=160\ MPa,\ M_x=40\ kNm,\ h=10^{-1}$ $m,\ b=2\cdot10^{-2}\ m,\ N_x=10\ kN,\ M_z=20\ kNm.$

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

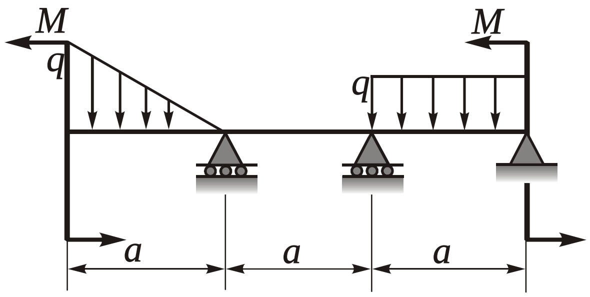
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 93

1. Equation of three moments (proof).
2. Conditions of Euler's formula applicability.

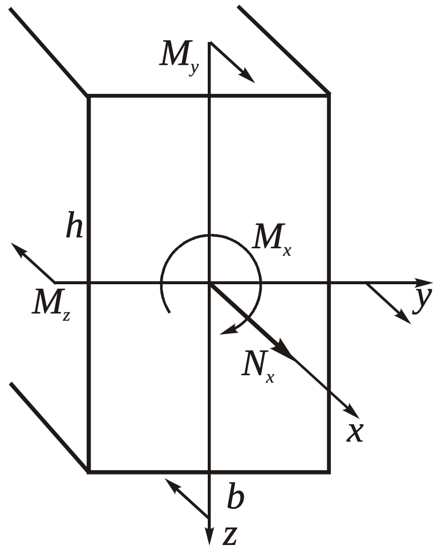
3.



Given: q=30 *kN/m*, a=2 *m*, M=40 *kNm*.

Aim: design the graphs Q_z, M_y.

4.



Check cross-sectional strength if $[s]=160$ *MPa*, $M_x = 20$ *kNm*, $M_y = 30$ *kNm*, $M_z = 40$ *kNm*, $h = 10^{-1}$ *m*, $b = 5 \cdot 10^{-2}$ *m*, $N_x = 10$ *kN*

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university “Kharkiv Aviation Institute”

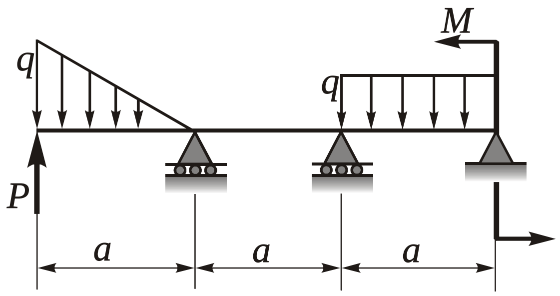
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **“Mechanics of materials”**

Examination card № 94

1. Equation of three moments (proof).
2. Assumptions in Laplace formula proof.

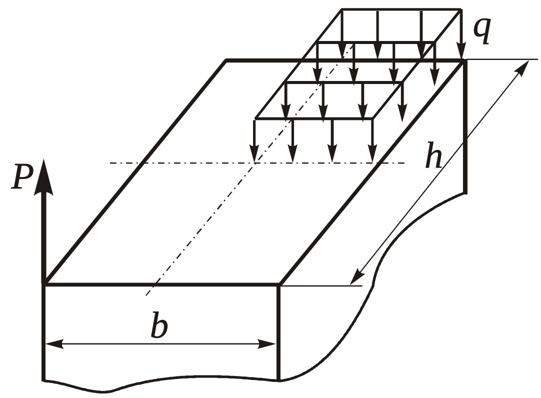
3.



Given: *P=20 kN*, *q*=30 *kN/m*, *a*=2 *m*, *M*=40 *kNm*.

Aim: design the graphs Q_z, M_y.

4.



Given: *P=20 kN*, *q*=10 *kN/m*^{2}, *b*=4 *см*, *h*=8 *cm*.

Aim: design graphs of stress distribution in an arbitrary section and find maximum stress.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

National aerospace university "Kharkiv Aviation Institute"

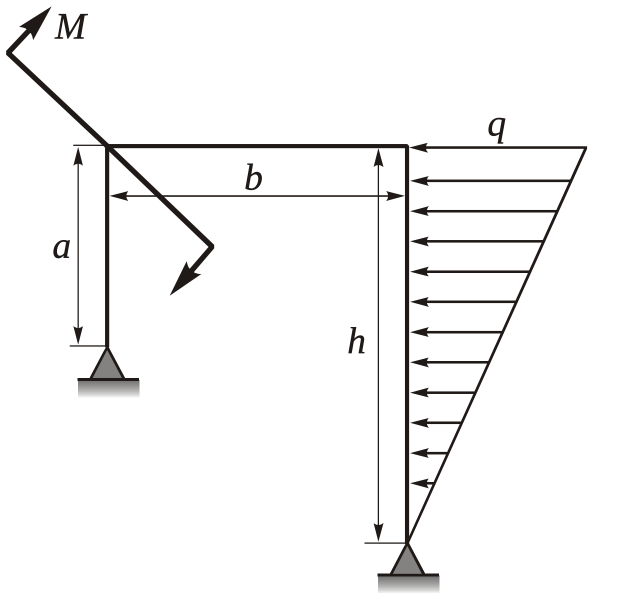
Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***

Course **"Mechanics of materials"**

Examination card № 95

1. Von Mises strength theory: proof of the condition of strength for principal and arbitrary stresses.
2. Eccentric compression: essence and method of critical point determination. Condition of strength.

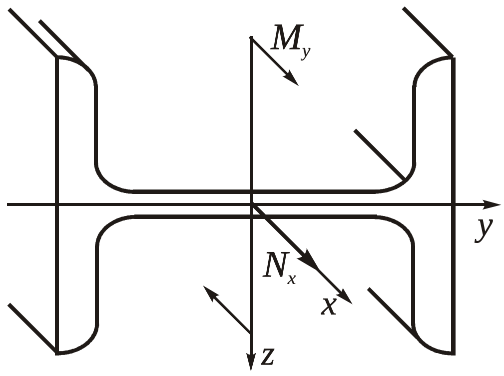
3.



Given: a=2 m, $b = 4$ m, $h = 3$ m, $q = 20$ kN/m, M=40 kNm.

Aim: design the graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$.

4.



Find position of neutral axis of I-beam №16 and check its strength if $M_y = 10$ kNm, $N_x = 10$ kN, $[s]$=160 MPa.

Accepted by Department of Aircraft Strength meeting.

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

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**

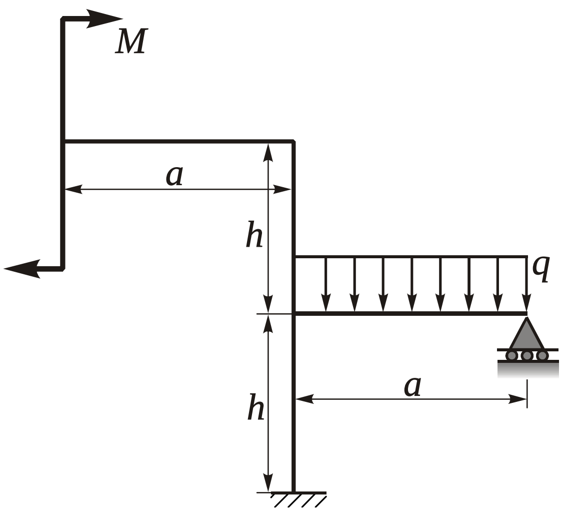
National aerospace university "Kharkiv Aviation Institute"

Degree B. Sc. Branch of education: 1001 **Aerospace Engineering** Semester ***IV***
Course **"Mechanics of materials"**

Examination card № 96

1. Laplace formula (proof).
2. General characteristics of the cycle of loading.

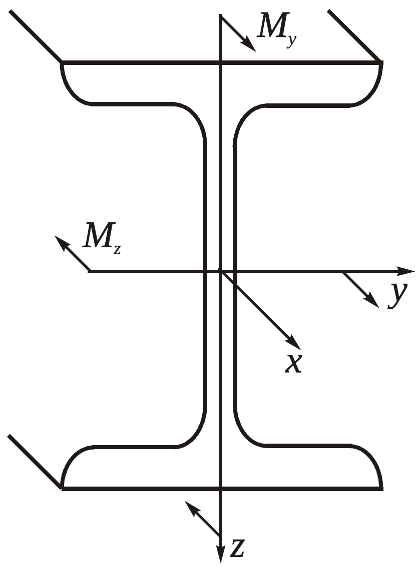
3.



Given: a=2 *m*, h=2 *m*, q=10 *kN/m*, M=20 *kNm*.

Aim: design the graphs $N_x(x)$, $Q_z(x)$, $M_y(x)$.

4.



Check strength of the section (I-beam №16), if $M_y = 30$ *kNm*, $M_z = 10$ *kNm*, $[s] = 160$ *MPa*. Find position of neutral axis.

Accepted by Department of Aircraft Strength meeting.
Record of proceeding № **3,** 21 November**,** 2011

Head of Department, Doctor of Science, Professor

Examiner **Demenko V.F.**