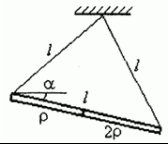
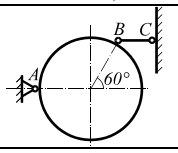
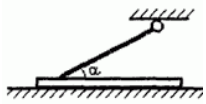
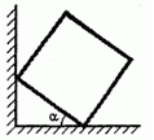
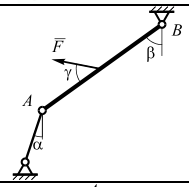
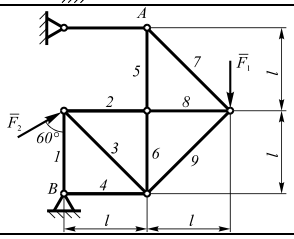
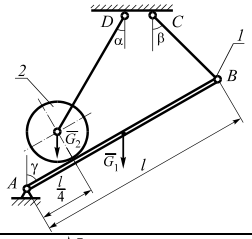
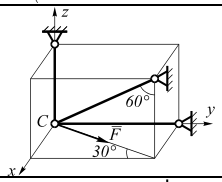
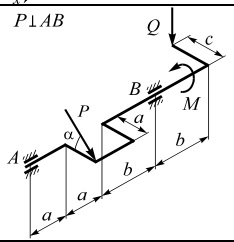
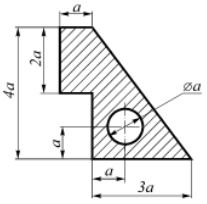
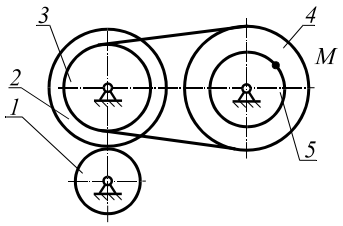
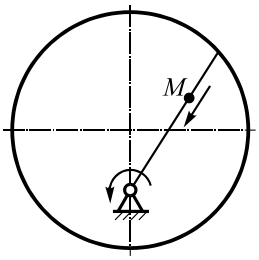
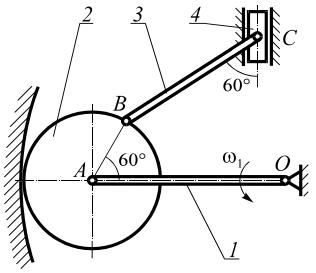
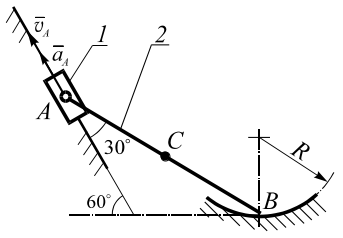
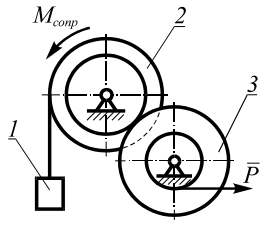
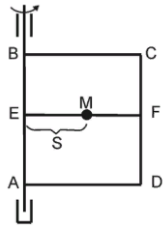
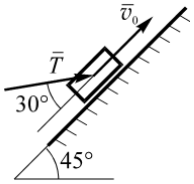
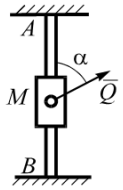
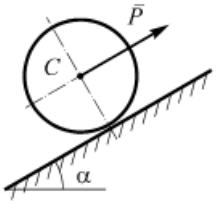
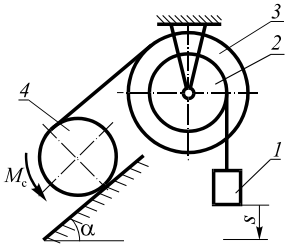
2019 INTERNATIONAL ENGINEERING MECHANICS CONTEST (ASIAN REGION)
The Brain-ring Team Contest

Statics

1		A rod of length l is hung by two threads of the same length. The rod is made up of two halves of the same size. What angle is between the rod and the horizon if the rod is in equilibrium and its halves are made of materials with densities ρ and 2ρ?
2		The disk of weight P = 21 N is held in balance by the hinge **A** and the weightless rod **BC**, as it is shown in the figure. Determine the reaction of the hinge **A**.
3		On a smooth horizontal surface lies a board, pressed against a uniform rod. The rod is inclined to the horizon at an angle α, and its upper end is hinged. At what value of the friction coefficient it will be impossible to pull the board to the right?
4		The cube stands in the corner of the room as it is shown in the figure. Find the minimal value of the angle α to provide the equilibrium of the cube, if the friction coefficient between the and the wall and the floor is the same and it is equal to 1/2.
5		An active force is applied to the middle of the weightless beam AB of length l. Angles $\alpha = \gamma - \beta$ and $\sin(\alpha + \beta) = 3\sin(\alpha-\beta)$. Find the reaction of the rod **A**.
6		Determine the reaction of the rod 6 if $\boldsymbol{F_1}$ = 20 N; $\boldsymbol{F_2} = 20\sqrt{3}$ N.
7		Given: G_1=2G, G_2=G, γ = α = 3β = 45°; $r_2 = l/5$. Find the reaction of the rod BC if the friction is neglected.
8		Find the sum of the modules of the reactions of rods attached to the node **C**, if F = 100 N.
9		Given: $P = 4mg$, $Q = mg$, $b = 1{,}5c = 2a = l$, $M = mgl$. Determine the angle α between the force P and the shown beam to provide its equilibrium.
10		Determine the distance from the center of gravity of the hatched figure to the center of the cut circle.

11	The cyclist moves at a velocity of 2 m/s. Then his movement becomes equally accelerated, and he moves 250 m in 20 seconds. Find the final velocity of the cyclist?	
12	According to the point motion equations in the coordinate form of $x(t) = 5 + 2\sin^2(t)$ m, $y(t) = 2 - 4\cos(2t)$ m, determine the radius of curvature of the point trajectory.	
13	The fan rotates at a velocity corresponding to a frequency of 900 rpm. After turning off the fan rotates equally slowly and it made 75 turns before the stop. How much time has passed since the fan was turned off until it was completely stopped?	
14	The tangential acceleration of a point which is 5 cm far from the axis of the rotating body varies depending on time according to the ratio $a_\tau = 2\pi t$ cm/s^2. Determine the normal acceleration of the point after 5 seconds from the start of body movement.	
15		Determine velocity of point **M** at time moment equal to 2 s, if the radii of the shown wheels $r_4 = 1{,}2r_3 = 2r_5 = r_2 = 2{,}5r_1 = R$ and the first wheel rotates according to the law $\varphi_1 = 2 - \frac{1}{2t^2}$.
16	In the equilateral triangle **ABC** each side is equal to $\sqrt{3}$ m. The triangle moves and at some time moment the point B velocity is equal to v and its vector lies along the side **AB.** At the same time the point **C** velocity is directed along the side **CB**. Find the velocity of point **A** at this time.	
17		Find the absolute acceleration of point **M**, its velocity is constant and equal to 1.2 m/s. The point moves along a line located in the plane of the rotating disk (ω = 2 rad/s, ω = const) at an angle of 30° to the vertical going through the disk rotation axis. Point **M** in the shown position is at a distance of 0.4 m from the disk rotation axis.
18		Find the point **C** velocity if **AO** = 1 m, **AB** = 0.4 m, **BC** = 0.75 m, ω_1 = 3 rad/s. Disk 2 moves without slipping.
19		Given: v_A = 30 cm/s; a_A = 20 cm/s; **AC** = 30 cm. Find the point **B** acceleration if $R \to \infty$.
20	The disk of radius r rolls without slipping along the convex surface of radius R. The velocity of the center of mass of the disk is constant and it is equal to v. Find the distance between the instantaneous center of velocities and the instantaneous center of accelerations of the disk.	

21	Two bodies are thrown vertically upwards with a time interval of 4 seconds with the same initial velocities of v = 30 m/s. At what time moment after the second body began to move the bodies will be at the same height?	
22	A bullet flying at a velocity of 400 m/s hits the earth and penetrates into a depth of 36 cm. What is the velocity of the bullet at a depth of 18 cm?	
23	A material point of mass m = 10 kg moves in space under the action of a force $F = 5\bar{i} - 6\bar{j} + 7\bar{k}$ N. Determine the module of the point acceleration.	
24	Vertical lifting of a mass m = 1000 kg is carried out by a rope wound on a drum of radius R = 0.25 m, the drum rotates with angular acceleration $\varepsilon = 2t$ rad/s^2. Determine the value of the rope tension force at time t = 5 s.	
25		The system of three bodies moves under the action of force P = 5mg. In addition, a system of forces acts on the system, creating a moment of resistance $M_{conp} = mgR$. Given: $m_1 = m$, $m_2 = 2m$, $m_3 = m$. Wheels radii: $R_2 = 1.2r_2 = R$, $R_3 = 2r_3 = R$. The radii of inertia of rotationally moving bodies are related to radius R: $i = \frac{1}{\sqrt{2}}R$. Determine the acceleration of the load 1.
26		The point **M** with a mass of 0.25 kg began to move in accordance with the law $s(t) = 0{,}05t^2$ m along a rough crossbar **EF** from point **E** to point **F**. The crossbar **EF** is on the contour **ABCD** rotating around the vertical axis **AB**, and the angular velocity of rotation $\omega(t) = 0{,}6\pi t$ rad / s. Determine the value of the point M-crossbar **EF** coefficient of sliding friction at t = 1s.
27		The body is located on an inclined plane, forming an angle of 45° with the horizon. The body had the initial velocity of 10 m/s. A force T equal to half of bodies weight and it is shown in the figure. The coefficient of sliding friction is 0.2. Determine the time of body movement before a stop.
28		The slider **M** of mass m = 20 kg moves along the vertical rod **AB** under the action of gravity. The motion of the slide is slowed with a force Q = 80 N, directed at an angle α = 45° to the rod. The friction coefficient f = 0.3. Determine the movement of the slider s if the slider velocity increased from 2 to 5 m/s.
29		Given: G = 100 N; f = 0.2; δ = 0.42 cm; R = 0.2 m, α = 45°. The roller should be considered as a continuous homogeneous cylinder. Define the maximal force P, corresponding to movement without sliding.
30		In the shown system the masses of all bodies are the same and equal to 2m. The bodies 2, 3, 4 are solid homogeneous cylinders. The wheel 4 is attached to the moment of resistance M_c. The coefficient of body-plane sliding friction is equal to f, the inclination angle of the plane to the horizon is α. Rolling in all cases occurs without slipping. Determine the sum of the work of all forces applied to the system, if the velocity of the load 1 is equal to v, and the radii R_3=2R_2. At the initial moment the system was at rest.

Note: the acceleration of gravity g=9,81 m/s^2; the value π = 3,14.