ПЕРЕЛІК ТИПОВИХ ЗАВДАНЬ ДЛЯ РОЗВ'ЯЗКУ, З ЯКИХ ФОРМУВАТИМУТЬСЯ БІЛЕТИ ДЛЯ ПРОВЕДЕННЯ МОДУЛЬНОЇ КОНТРОЛЬНОЇ РОБОТИ

МОДУЛЬ 1

1. Main definitions (machine, element, subassembly, two groups of machine elements).
2. Design and checking calculation Criteria of serviceability (characterize every criterion).
3. Determination of acting and allowable stresses. Strength condition for tension (compression), torsion, shear and bending.
4. Determination of allowable stresses for plastic and brittle materials, variable loads.
5. Transmissions. Classification.
6. Parameters of mechanical drive
7. Gearings. Advantages of gearings. Classification of gearings
8. Failure of teeth (characterize every of them).
9. Materials and heat treatment of toothed wheels
10. Calculation of allowable contact and bending stresses
11. Geometry of standard spur gears. Forces in the engagement of spur gear
12. Helical gears features. Forces in the engagement. Equivalent straight spur gear
13. Bevel gears. Geometry of bevel gears. Forces in the engagement
14. Worm gearings. Advantages and disadvantages of worm gears. Geometry of the worm and worm gear.
15. Forces in the engagement of the worm gearing. Material for worm gearing. Heat removal analysis of the worm gearing
16. Belt drives. Classification. Advantages and disadvantages.
17. Chain drives. Classification. Advantages and disadvantages.

Examples of problems

1. Determine centre distance a_w, gear face width b^g, pinion and gear nominal pitch circle diameters d^g, d^p, addendum circle diameters $d_a{}^g$, $d_a{}^p$, dedendum circle diameters $d_f{}^g$, $d_f{}^p$ of standard involute straight spur gear, if $z^p=17$, $z^g=51$, $m=3$ mm, $\psi_{ba}=0.4$.

2. Determine module m, nominal pitch circle diameter d, addendum circle diameter d_a, dedendum circle diameter d_f and pitch P of the straight spur gear with external contact, if whole depth of a tooth h = 13.5 mm, number of teeth z = 25.

3. Determine normal module m_n, helix angle β, dedendum circle diameter d_f, normal pitch P_n, dedendum of a tooth h_f of the helical spur gear, if addendum circle diameter $d_a=120$ mm, nominal pitch circle diameter d=112 mm and number of teeth z = 27.

4. Determine pitch angles δ^p, δ^g, outer cone distance R_e, gear face width b^g, external pitch circle diameter $d_e{}^p$, external addendum circle diameter $d_a{}^p$ of the pinion of bevel gears, if $z^p=20$, $z^g=63$, $m_e=3$ mm, $\psi_{bR}=0.285$.

5. Determine external module m_e, number of teeth of the gear z^g, outer cone distance R_e, external addendum circle diameter $d_a{}^g$, external dedendum circle diameter $d_f{}^g$ of the gear of bevel gears, if $d_e{}^g = 135$ mm, $h_f= 3.6$ mm, $\delta^g=75$ º.

6. Determine centre distance a_w of the worm gearing, worm and worm gear pitch circle diameters d^w, d^g, major and minor diameters of the worm $d_a{}^w$ and $d_f{}^w$, lead angle γ of the worm, if $z^w=1$, $z^g=55$, $q^w=8$, $m=4$ mm.

7. Determine axial module m, worm and worm gear pitch circle diameters d^w, d^g, addendum and dedendum circle diameters of the worm gear $d_a{}^g$ and $d_f{}^g$, lead angle γ of the worm, if $a_w= 130$ mm, $z^w=2$, $z^g = 42$, $q^w=10$.

8. Determine velocity ratio u, efficiency η, input and output torques T_{inp},T_{out}, input and output rotational speeds n_{inp}, n_{out} for single – stage speed reducer, if $P_{inp}=4$ kW, $P_{out}=3.5$ kW, $\omega_{inp}=100$ sec $^{-1}$, $z^p=20$, $z^g=60$.

9. Determine normal force F_n, turning force F_t and radial force F_r, acting at the engagement of straight spur gears, if torque at the pinion $T^p=400$ N m, nominal pitch circle diameter of the pinion $d^p=80$ mm, pressure angle $\alpha_w=20$º.

10. Determine normal force F_n, turning force F_t , radial force F_r and axial force F_a acting at the engagement of helical spur gears, if torque at the pinion $T^p=520$ N m, nominal pitch circle diameter of the pinion $d^p=80$ mm, helix angle $\beta=10$º, pressure angle $\alpha_w=20$º.

11. Determine normal force F_n, turning force F_t , radial force F_r and axial force F_a acting on the pinion of bevel gears, if torque at the pinion $T^p= 350$ N m, mean pitch circle diameter of the pinion $d_m{}^p= 100$ mm, pitch angle $\delta^p=16$ º , pressure angle $\alpha_w=20$º.

12. Determine normal force F_n, turning force $F_t{}^g$, radial force $F_r{}^g$ and axial force $F_a{}^g$ acting at the engagement of the worm gearing, if torque at the worm $T^w=120$ N m, torque at the worm gear $T^g= 1350$ Nm, major diameter of the worm $d^w=80$ mm, pitch circle diameter of the worm gear $d^g= 250$ mm, lead angle $\gamma=13$ º, pressure angle $\alpha_w=20$º.

МОДУЛЬ 2

1. Shaft and axles. Definitions. Classification. Materials. Strength analysis of shafts.
2. Determination of the shaft minimal diameter. Designing the shaft construction.
3. Bearings (sliding contact bearings and rolling contact bearings). Advantages (disadvantages) of rolling contact bearings.
4. Classification of rolling contact bearings. Main failures. Calculation of rolling contact bearings
5. Couplings. Coupling functions. Classification.
6. Keyed joints. Advantages and disadvantages. Classification.
7. Splined joints. Advantages and disadvantages. Classification.
8. Threaded joints. Advantages and disadvantages. Characterise threaded joints formed by a bolt, a screw and a stud
9. Classification of threads. Geometrical parameters of the cylindrical thread.
10. Riveted joints. Materials. Advantages and disadvantages.
11. Riveted joints. Classification. Efficiency. Strength analysis.
12. Welded joints. Advantages and disadvantages. Classification. Strength analysis.

Examples of problems

1. Determine the minimal diameter and design the shaft of the single stage bevel gear speed reducer if T = 300 N m, $[\tau]$ = 20 MPa.

2. Determine rated life in hours Lh for tapered roller bearing with movable inner ring, if F_r = 15 kN, F_a=5 kN, X= 0.6, Y= 1.8, C= 40 kN, n= 120 rpm, t<100 °C, Ks=l.3.

3. Determine basic load rating C for radial-thrust ball bearing with movable inner ring, if F_r=16 kN, F_a=2 kN, X =0.45, Y=1.62, L_h=12000 hours, n=80 rpm, t<100 ºC, Ks=1.3.

4. Select a sunk key for the shaft of diameter d=40 mm and analyse it for bearing strength and shearing strength, if torque T=250 N m, design key length l_d=56 mm, $[\sigma_{bear}]$=100 MPa, $[\tau_{shear}]$=60 MPa.

5. Determine bolt diameter d of the tightened threaded joint loaded by a torque only, if F_{ten}=8 kN, $[\sigma_{ten}]$=100 MPa.

6. Determine bolt diameter d of the threaded joint loaded by an axial force F_a only, if F=7 kN, $[\sigma_{ten}]$=100 MPa.

7. Determine bolt diameter d of the threaded joint when bolt is fitted into hole with some play, if F= 2 kN (not F_{pr}), $[\sigma_{ten}]$= 130 MPa, f = 0.2, i=2.

8. Determine bolt diameter d_0 of the threaded joint when bolt is fitted into hole with small interference, if F= 8 kN, $[\tau]$ = 60 MPa

9. Determine the number of required rivets if the rivet diameter d = 4 mm, shearing force F = 17 kN, the minimum thickness of the plate δ = 3 mm and the allowable shearing stress $[\tau]$ = 270 MPa.

10. Determine the bearing force F of riveted joint if the rivet diameter d = 4 mm, number of rivets z = 4, the minimum thickness of the plate δ_{min} = 10 mm and the allowable bearing stress $[\sigma]$ = 250 MPa.

11. Determine the plate width (b) if the rivet diameter d = 6 mm, z = 2, the minimum thickness of the plate δ_{min} = 7 mm, tearing force F = 28 kN , and the allowable tensile stress $[\sigma]$ = 400 MPa.

12. Check lap weld for shear if the shearing force *F* = 12 кН, length weld *l* = 40 мм, thickness of the plate δ (k) = 7,5 мм. Allowable shear stress $[\tau]'$ = 100 МПа.

13. Determine the tearing force of the butt weld, if thickness δ = 6 mm, width b= 70 mm. The allowable tensile stress $[\sigma]'$ = 110 MPa.