IBONG TIRIRIT (MDSP 1)
MACHINE DESIGN AND SHOP PRACTICE PROBLEMS

ELEMENTS (with answers and solutions)

1. This radial distance in a gear is measured between the addendum and dedendum circle, and is the sum of the addendum and the dedendum? How do you call this distance?
   a) Addendum b) Whole depth c) Working depth d) Space width

   Answer: b) Whole depth

2. What is the polar section modulus of a solid shaft with a diameter of 101.6 mm?
   a) 209.5 cm^3 b) 209.5 cm^4 c) 205.9 cm^3 d) 205.9 cm^4

   Answer: c) 205.9 cm^3

   Solution: $Z_j = \frac{J}{c} = \frac{2J}{D} = \frac{\pi}{16} D^3 = \frac{\pi}{16}(10.16)^3 = 205.9 \text{ cm}^3$

3. This minimum distance is measured between the non-driving side of a tooth and the adjacent side of the mating tooth. It is the amount by which the width of a tooth space exceeds the thickness of the engaging tooth measured on the pitch circle. What is this distance?
   a) Circular pitch b) Whole depth c) Backlash d) Space width

   Answer: c) Backlash

4. With the water interruptions prevailing in your town, you have been asked to design an upright cylindrical water tank 6 meters in diameter and 6 meters high, vented, and to be filled completely with water. Determine the minimum thickness of the tank plate if the stress is limited to 40 Mpa.
   a) 3.3 mm b) 4.4 mm c) 5.5 mm d) 8.8 mm

   Answer: b) Thickness, t = 4.4 mm

   Solution: $p = \rho gh = (1000)(9.8066)(6) = 58\,839.6 \text{ Pa} = 58.8396 \text{ kPa}$

   $$t = \frac{pD}{2s_t} = \frac{(58.8396)(6)}{2(40\,000)} = 0.00441 \text{ m} = 4.41 \text{ mm}$$

5. What is the algebraic difference between the maximum limit and the corresponding basic size?
   a) Fundamental deviation b) Upper deviation c) Lower deviation d) Tolerance

   Answer: b) Upper Deviation

6. A steel shaft 1.75 inches in diameter transmits 40 Hp at 1800 rpm. Assuming a modulus of rigidity of 12 x 10^6 psi, find the torsional deflection of the shaft in degrees per foot length.
   a) 0.0073 b) 0.0037 c) 0.0063 d) 0.00013

   Solution: $\frac{\theta}{L} = \frac{T}{JG} = \frac{32T}{\pi D^4 G} = \frac{32\left(\frac{63\,000 \text{ Hp}}{n}\right)}{\pi D^4 G} = \frac{32\left[\frac{63000(40)}{1800}\right]}{\pi(1.75)^4\left(12 \text{ x } 10^6\right)} = 0.00013 \text{ radian} = 0.0073$

7. What is the algebraic difference between the minimum limit and the corresponding basic size?
   a) Fundamental deviation b) Upper deviation c) Lower deviation d) Tolerance

   Answer: c) Lower Deviation

8. A helical-coil spring has a mean coil diameter of 1 inch and a wire diameter of 1/8 inch. Determine the curve correction factor of the spring.
   a) 1.144 b) 1.44 c) 1.1144 d) 1.1414

   Answer: Curve Correction Factor, $K_c = 1.1144$

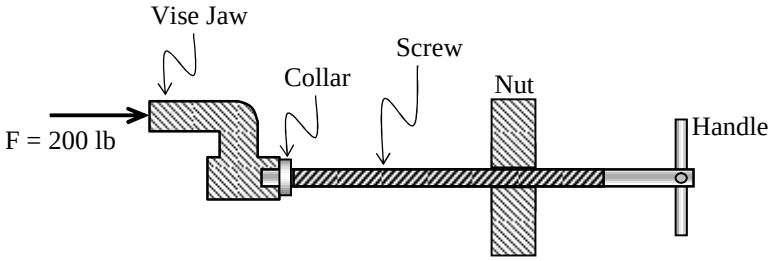
   Solution: $K_c = \dfrac{K_w}{K_s} = \dfrac{\dfrac{4C-1}{4C-4} + \dfrac{0.615}{C}}{\dfrac{2C+1}{2C}} = \dfrac{1.184}{1.0625} = 1.1144$

9. This is either the upper or the lower deviation, depending on which is closer to the basic size. How do you call this deviation?
   a) Fundamental deviation b) Upper deviation c) Lower deviation d) Tolerance

   Answer: Fundamental deviation

10. A vise is equipped with a 1-inch single square thread, with 4 threads per inch. The frictional radius of the collar is 0.5 inch. The coefficient of friction for both the collar and threads is 0.20. How much external torque must be applied to produce a force of 200 lb against the jaws of the vise?
    a) 39.73 in-lb b) 33.97 in-lb c) 37.93 in-lb d) 39.37 in-lb

    Answer: c) 37.93 in-lb



Solution:

For the thread pitch, $p = \dfrac{1}{\text{Number of Threads per Inch}} = \dfrac{1}{4} = 0.25 \text{ inch}$

For the minor diameter, $D_i = D_o - p = 1 - 0.25 = 0.75$ inch

For the mean or pitch diameter of the screw, $D_m = \dfrac{D_o + D_i}{2} = \dfrac{1 + 0.75}{2} = 0.875 \text{ inch}$

For the lead angle,

$$\lambda = \tan^{-1}\left(\frac{L}{\pi D_m}\right) = \tan^{-1}\left(\frac{p}{\pi D_m}\right) = \tan^{-1}\left(\frac{0.25}{0.875\pi}\right) = \tan^{-1} 0.09095 = 5.197^{o}$$

Solving for the torque required to overcome the collar friction,

$$T_c = \frac{fFD_c}{2} = \frac{(0.2)(200)(0.5)}{2} = 20 \text{ in} \cdot \text{lb}$$

Solving for the torque required to overcome the thread friction,

$$T_s = \frac{FD_m}{2}\left(\frac{\tan\lambda + f}{1 - f\tan\lambda}\right) = \frac{200(0.875)}{2}\left[\frac{0.09095 + 0.2}{1 - 0.2(0.9095)}\right] = 25.93 \text{ in} \cdot \text{lb}$$

Solving for the total torque,

$T = T_s + T_c = 25.93 + 20 = 45.93$ inches ans.

11. What is the difference between the maximum and minimum size limits of a part?
a) Allowance b) Tolerance c) Deviation d) Basic size

Answer: b) Tolerance

12. A helical-coil spring has a mean coil diameter of 1 inch and a wire diameter of 1/8 inch. Determine the Wahl factor of the spring.
a) 1.148 b) 1.184 c) 1.418 d) 1.814

Answer: b) Wahl Factor, $K_w = 1.184$

Solution: $C = \frac{D_m}{d} = \frac{1}{1/8} = 8$ $K_w = \frac{4C-1}{4C-4} + \frac{0.615}{C} = \frac{4(8)-1}{4(8)-8} + \frac{0.615}{8} = 1.184$

13. It is the capacity of a material to absorb energy when it is deformed elastically and then, upon unloading, to increase this energy. What is this capacity of a material?
a) Resilience b) Toughness c) Rigidity d) Ductility

Answer: a) Resilience

14. A helical-coil spring has a mean coil diameter of 1 inch and a wire diameter of 1/8 inch. Determine the value of Bergstrassar factor of the spring.
a) 1.172 b) 1.712 c) 1.217 d) 1.271

Answer: a) Bergstrassar Factor, $K_B = 1.1724$

Solution: $C = \frac{D_m}{d} = \frac{1}{1/8} = 8$ $K_B = \frac{4C+2}{4C-3} = \frac{4(8)+2}{4(8)-3} = 1.1724$

15. How do you call the strain energy per unit volume required to stress a material from an unloaded state to the point of yielding?
a) Modulus of roughness b) Modulus of elasticity c) Modulus of rigidity d) Modulus of resilience

Answer: d) Modulus of Resilience

16. Compute the tooth thickness of a 14.5^o spur gear with diametral pitch of 5.
a) 0.23140 inch b) 0.31416 inch c) 0.43140 inch d) 0.03140 inch

Answer: b) Tooth thickness, $t = 0.31416$ inch

Solution: $t = \frac{1.5708}{p_d} = \frac{1.5708}{5} = 0.31416$ inch

17. How do you call a structural member designed to support loads perpendicular to its longitudinal axis?
a) Cantilever beam b) Beam c) Overhanging beam d) Column

Answer: b) Beam

18. Compute the speed of the gear mounted on a 52.5 mm diameter shaft receiving power from a driving motor with 250 Hp.

a) 2 182 rpm b) 2 071 rpm c) 2 265 rpm d) 2 341 rpm

Answer: c) The speed, N = 2265 rpm

Solution: From PSME Code: $N = \frac{80\,P}{D^3} = \frac{80(250)}{\left(\frac{52.5}{25.4}\right)^3} = 2\,264.92 \text{ rpm}$

19. It is a load applied transversely to longitudinal axis of member. How do you call this load?
a) Bending load b) Combined load c) Distributed load d) Cyclic load

Answer: a) Bending load

20. What is a load distributed over an entire area?
a) Bending load b) Combined load c) Distributed load d) Cyclic load

Answer: c) Distributed load

21. Compute the working strength of 1 inch bolt which is screwed up tightly in packed joint when the allowable working stress is 13000 psi.
a) 3 600 lb b) 3 950 lb c) 3 900 lb d) 3 800 lb

Answer c) The working strength, W = 3 900 lb

Solution: From machinery's Handbook, page 1149: $W = s_t\left(0.55d^2 - 0.25d\right) = (13\,000)\left[0.55(1)^2 - 0.25(1)\right] = 3900 \text{ lb}$

22. It is a design approach where no catastrophic loss can occur as a result of a component failure. What is this design approach?
a) Fail-safe design approach b) Fault free analysis approach
c) Manifest danger approach d) Redundancy approach

Answer: a) Fail-safe design approach

23. It is the condition of a machine element when it is completely inoperable, cannot perform its intended function adequately, or is unreliable for continued safe use. What do you call this condition?
a) Fail-safe condition b) Failure condition c) Critical condition d) Salvage condition

Answer: b) Failure condition

24. Compute the nominal shear stress at the surface, in MPa, for a 50 mm diameter shaft that is subjected to a torque of 0.48 kN-m.
a) 16.95 b) 21.65 c) 19.56 d) 25.12

Answer: Shear Stress, s_s = 19.56 MPa

Solution: $s_s = \frac{16\,T}{\pi D^3} = \frac{16(0.48)}{\pi\,(0.050)^3} = 19\,556.96 \text{ kPa} = 19.56 \text{ MPa}$

25. How do you call a statistical data used to identify the most likely failure modes?
a) Finite element analysis b) Fault free analysis c) Failure analysis d) Random analysis

Answer: b) Fault free analysis

26. A hollow iron pipe to be designed as a column has an outside diameter of 240 mm and is subjected to a force of 80 KN. Find the pipe thickness if the compressive stress is limited to 16 MPa.
a. 5.85 mm b. 6.85 mm c. 7.85 mm d. 8.85 mm

Answer: b) Pipe thickness, t = 6.85 mm

Solution: Inside Diameter, $D_i = \sqrt{D_o^2 - \frac{4F}{\pi s}} = \sqrt{(0.24)^2 - \frac{4(80)}{\pi(16\,000)}} = 0.2263\,\text{m} - 226.3\ \text{mm}$

Thickness of the Pipe, $t = \frac{D_o - D_i}{2} = \frac{240 - 226.3}{2} = 6.85\ \text{mm}$

27. It is a computational method used for solving complex shapes, such as those found in machinery; replaces the complex shape with a set of simple elements interconnected at a finite set of a specific purpose. What is this computational method?
    a) Finite element analysis b) Numerical method of analysis
    c) Fault free analysis d) Synthesis

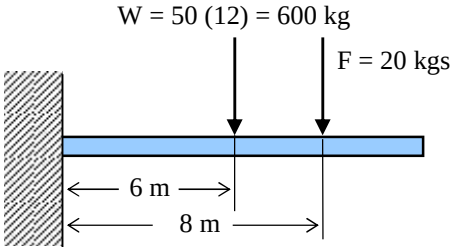
    Answer: a) Finite element analysis

28. A uniform beam 12 meters long is fixed at one end. It has a uniform weight of 50 kg/m along its length. A load of 20 kgs. is suspended on the beam 4 m from the free end. The moment at the fixed end is
    a. 3760 kg-m b. 0.0 kg-m c. 60 kg-m d. 4800 kg-m

    Answer: a) 3760 kg-m

    Solution: Bending Moment,

    $M = 6(600) + 8(20) = 3760\ \text{kg} \cdot \text{m}$



29. When a hot part is cooled suddenly by quenching, there is momentarily a high temperature gradient that induces a stress gradient. Some metal parts under certain conditions crack as a result. How do you call this phenomenon?
    a) Thermal-shock failure b) Thermal fatigue c) Honing d) Quenching

    Answer: a) Thermal-shock failure

30. A 20° straight-tooth bevel pinion having 14 teeth and a diametral pitch of 6 teeth/inch drives a 42-tooth gear. The two shafts are at right angles and in the same plane. Find the pitch angle of the pinion.
    a) 18.4° b) 20° c) 14.5° d) 20.5°

    Answer: a) Pitch angle of the pinion = 18.4°

    Solution: $\gamma = \tan^{-1}\left(\frac{T_p}{T_g}\right) = \tan^{-1}\left(\frac{14}{42}\right) = 18.4^\circ$

31. How do you call the diameter of the imaginary cylinder that bounds the crest of an external thread and the roots of an internal thread?
    a) Mean diameter b) Stress diameter c) Minor diameter d) Major diameter

    Answer: d) Major diameter

32. A 20° straight-tooth bevel pinion having 14 teeth and a diametral pitch of 6 teeth/inch drives a 32-tooth gear. The two shafts are at right angles and in the same plane. The pinion is to transmit 1800 rpm and transmitting 50 hp. Determine the pitch diameters of the gears.
    a) 2.33 inches and 5.36 inches b) 3.23 inches and 3.56 inches
    c) 5.36 inches and 6.36 inches d) 2.33 inches and 2.33 inches

    Answer: a) 2.33 inches and 5.36 inches

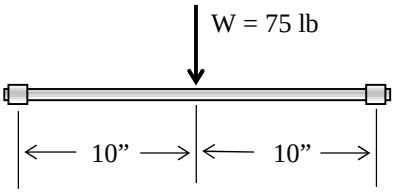
Solution: $D_1 = \frac{T_1}{P_d} = \frac{14}{6} = 2.33$ inches $\qquad D_2 = D_1\left(\frac{T_2}{T_1}\right) = (2.33)\left(\frac{32}{14}\right) = 5.36$ inches

33. It is a measure of the change in length of a material subjected to a change in temperature. How do you call this property of the material?
    a) Toughness b) Coefficient of thermal expansion
    c) Thermal conductivity d) Electric Resistivity

    Answer: b) Coefficient of thermal expansion

34. A 1-inch diameter shaft has a single disc weighing 75 lb mounted midway between two bearings 20" apart. Find the lowest critical speed in rpm. Neglect the weight of the shaft. Assume that the modulus of elasticity is 30 x 10^6 psi.
    a) 2038 rpm b) 2308 rpm c) 2380 rpm d) 2803 rpm

    Solution:

    D = 1 inch E = 30 x 10^6 psi L = 20 inches

    Moment of Inertia, $I = \frac{\pi D^4}{64} = \frac{\pi(1)^4}{64} = 0.0491$ in.^{4}

    Solving for the lowest critical speed, $\omega_{cr} = \sqrt{\frac{576 E I g}{W L^3}} = \sqrt{\frac{(576)(30 \text{ x } 10^6)(0.0491)(32.2)}{(75)(20)^3}} = 213.39$ rad/s

    $$N_{cr} = \frac{30\omega_{cr}}{\pi} = \frac{30(213.39)}{\pi} = 2037.68 \text{ rpm}$$

35. What is a condition where one surface is comparatively free of stress?
    a) Octahedral plane b) Biaxial or Plane stress c) Strain plane d) Principal normal stress

    Answer: b) Biaxial or Plane stress

36. A flywheel weighing 457 kg has a radius of 375 mm. How much energy, in N-m, does the flywheel loss from 3 rps to 2.8 rps?
    a) 368 b) 150 c) 1474 d) 38

    Answer: c) Flywheel Energy =1474

    Solution: $V_1 = 2\pi(0.375)(3) = 7.069$ m/s $\qquad V_2 = 2\pi(0.375)(2.8) = 6.597$ m/s

    $$\Delta KE = \frac{m\left(V_1^2 - V_2^2\right)}{2} = \frac{457\left[(7.069)^2 - (6.597)^2\right]}{2} = 1473.91 \text{ N} \cdot \text{m}$$

37. How do you call the circle on a gear that corresponds to the contact surface of the friction wheel?
    a) Addendum circle b) Root circle c) Pitch circle d) Base circle

    Answer: c) Pitch circle

38. A triple threaded worm has a pitch diameter of 3 inches. The wheel has 25 teeth and a pitch diameter of 5 inches. Material for both the wheel and the wheel is phosphor bronze. Determine the helix angle of the gear.
    a) 11.31° b) 13.11° c) 11.13° d) 10.13°

    Answer: Gear Helix angle = 11.31°

Solution: Circular pitch of the worm gear, $P_c = \frac{\pi D_g}{T_g} = \frac{\pi(5)}{25} = 0.6283$ inch

Where, $P_c = P_a$ = pitch of the worm

Solving for the lead, $L = N_t P_a = 3(0.6283) = 1.8849$ inches

Solving for the lead angle of the worm, $\lambda = \tan^{-1}\left(\frac{L}{\pi D_w}\right) = \tan^{-1}\left(\frac{1.8849}{3\pi}\right) = 11.31^o$

For the helix angle, and considering that the shafts angle is 90º,

$\psi_g = \lambda = 11.31^o$ ans.

39. This material is the most popular alloy spring steel for conditions involving higher stresses than can be used with the high-carbon steels and for use where fatigue resistance and long endurance are needed; this is also good for shock and impact loads.
a) Chrome silicon b) Chrome vanadium c) hard-drawn wire d) Oil-tempered wire

Answer: b) Chrome Vanadium

40. What is the largest roller chain size that can be used for power transmission at a sprocket speed of 1000 rpm?
a) RC 35 b) RC 50 c) RC 80 d) RC 60

Answer: d) RC 60

Note: Max. Chain Pitch in Practice: $p_{max} \le \left(\frac{900}{n}\right)^{\frac{2}{3}}$ $p_{max} = \left(\frac{900}{1000}\right)^{\frac{2}{3}} = 0.932$ in

Since RC 80, p = 1 inch exceeds the maximum and RC 70 does not exist, and then use RC 60.

41. These are gears with teeth formed on conical surfaces and are used mostly for transmitting motion between intersecting shafts. How do you call these gears?
a) Spur gears b) Helical gears c) Bevel gears d) Worm gearings

Answer: c) Bevel gears

42. A single square thread power screw is to raise a load of 70 kN. The screw has a major diameter of 36 mm and a pitch of 6 mm. The coefficient of thread friction and collar friction are 0.13 and 0.10 respectively. If the collar mean diameter is 90 mm and the screw turns at 60 rpm, find the axial linear speed of the screw.
a) 5 mm/s b) 6 mm/s c) 7 mm/s d) 5.5 mm/s

Answer: b) 6 mm/s

Solution: For the linear speed of the screw, $V_n = n\,(L) = (60\text{ rpm})(6\text{ mm/rev}) = 360\text{ mm/min} = 6\text{ mm/s}$

43. A double thread ACME screw driven by a motor at 400 rpm raises the attached load of 900 kg at a speed of 10 m/min. The screw has a pitch diameter of 36 mm; the coefficient of friction on threads is 0.15. The friction torque on the thrust bearing of the motor is taken as 20 % of the total input. Determine the lead angle.
a) 12.465º b) 14.265º c) 15.462º d) 16.452º

Answer: a) 12.465º

Solution: For the lead, $L = \frac{V}{n} = \frac{10}{400} = 0.025\text{ m} = 25\text{ mm}$

For the lead angle, $\lambda = \tan^{-1}\left(\frac{L}{\pi D_m}\right) = \tan^{-1}\left(\frac{25}{36\pi}\right) = 12.465^o$

44. What Hp can a 1-inch diameter short shaft transmit at 380 rpm?
a) 3 Hp b) 18 Hp c) 10 Hp d) 7.1 Hp

Answer: c) 10 Hp

Solution: $P = \frac{D^3 N}{38} = \frac{(1)^3 (380)}{38} = 10 \text{ Hp}$

45. A spur pinion rotates at 600 rpm and transmits 25 kW to a mating gear. The pitch diameter of the pinion is 100 mm, and the pressure angle is 20°. Determine the tangential load, in N.
a) 7660 b) 6790 c) 3900 d) 3098

Solution: $F_t = \left(\frac{2}{D}\right)\left(\frac{30P}{\pi n}\right) = \left(\frac{2}{0.10}\right)\left[\frac{30(25000)}{\pi(600)}\right] = 7957.75 \text{ N}$

46. A bearing that primarily guides the motion of a machine member without specific regard to the direction of load application.
a) Journal bearing b) Clearance bearing c) Guide bearing d) Thrust bearing

Answer: c) Guide bearing

47. A multiple-disk clutch, composed of three plates with a small diameter of 150 mm and large diameter of 200 mm, is designed to transmit 100 kW at 3000 rpm at a coefficient of friction of 0.5. Determine the spring force needed to engage the clutch.
a) 2820 N b) 2428 N c) 5460 N d) 3638 N

Answer: 3638 N

Solution: $T = \frac{30P}{\pi n} = \frac{30(100)}{\pi (3000)} = 0.3183 \text{ kN} \cdot \text{m} = 318.3 \text{ N} \cdot \text{m}$ $\quad T = f \cdot P \cdot r_f \cdot N_{fs} = f \cdot P \cdot \left[\frac{(D+d)}{4}\right] \cdot N_{fs}$

$$P = \frac{4T}{f \cdot (D+d) \cdot N_{fs}} = \frac{4(318300)}{0.5(200+150)(2)} = 3637.71 \text{ N}$$

48. A wire rope lifts a load of 10 kips at a maximum speed of 1000 feet per minute, attained in 5 seconds starting from rest. The rope has a metallic cross sectional area of 0.4 in^2. Determine the maximum tensile stress on the rope in ksi.
a) 26.2 b) 25.0 c) 27.6 d) 32.4

Answer: c) maximum tensile stress = 27.6 MPa

Solution: $a = \frac{V_1 - V_o}{t} = \frac{(1000/60) - 0}{5} = 3.33 \text{ fps}^2$ $\quad F = W_L\left(1 + \frac{a}{g}\right) = (10000)\left(1 + \frac{3.33}{32.2}\right) = 11034.16 \text{ lb}$

$$S_t = \frac{11{,}034.16}{0.4} = 27585.4 \text{ psi} = 27.6 \text{ ksi}$$

49. What is the bursting steam pressure of a hemispherical steel shell with a diameter of 100 inches and made of 0.0635-m thick steel plate, if the joint efficiency is 70 % and the tensile strength is 60 000 psi?
a) 4 020 psi b) 4 200 psi c) 2 400 psi d) 2 040 psi

Answer: b) 4200 psi

Solution: $p = \frac{4 t s_l E_j}{D} = \frac{4\left(\frac{63.5}{25.4} \text{ in}\right)(60000 \text{ lb/in}^2)(0.70)}{100 \text{ in.}} = 4200 \text{ psi}$

Where, p = bursting pressure, psi s_l = shell stress, psi
t = shell thickness, inches D = shell diameter, inches E_j = joint efficiency

Note: For the longitudinal stress of the thin-walled cylinder, and the stress for spherical tank: $s_L = \dfrac{p\,D}{4\,t\,E_j}$

50. A cylinder having an internal diameter if 508 mm and external diameter if 914.4 mm is subjected to an internal pressure of 69 MPa and an external pressure of 14 MPa. Determine the hoop stress at the inner surface of the cylinder.
a) 90.11 MPa b) 91.10 MPa c) 911.0 MPa d) 19.10 Mpa

Answer: a) 90.11 MPaa

Solution: $$s_{ti} = \frac{p_i\left(r_o^2 + r_i^2\right) - 2p_o r_o^2}{r_o^2 - r_i^2} = \frac{(69\ \text{MPa})\left[\left(\frac{914.4}{2}\ \text{mm}\right)^2 + \left(\frac{508}{2}\ \text{mm}\right)^2\right] - 2(14\ \text{MPa})\left(\frac{914.4}{2}\ \text{mm}\right)^2}{\left(\frac{914.4}{2}\ \text{mm}\right)^2 - \left(\frac{508}{2}\ \text{mm}\right)^2}$$

s_{ti} = 90.11 Mpa

Where, s_{ti} = maximum tangential or hoop stress at the inside r_i = inside radius, mm
p_i = internal pressure, Mpa r_o = outside radius, mm
p_o = external pressure, Mpa

Note: For the maximum tangential or hoop stress at the outside, $s_{to} = \dfrac{2p_i r_i^2 - p_o\left(r_o^2 + r_i^2\right)}{r_o^2 - r_i^2}$

51. What length of a square key is required for a 4-in diameter shaft transmitting 1000 hp at 1000 rpm? The allowable shear and compressive stresses in the key are 15 ksi and 30 ksi, respectively.
a) 2.1 inches b) 2.8 inches c) 3.2 inches d) 4.2 inches

Answer: a) 2.1 inches

Solution: Transmitted torque, $T = \dfrac{63000\,Hp}{n} = \dfrac{63000(1000)}{1000} = 63000\ \text{in}\cdot\text{lb}$

Key width, $b \approx \dfrac{D}{4}$, for good proportion

Key length based on shear, $L = \dfrac{2T}{s_s b D} = \dfrac{2(63000)}{15000(1)(4)} = 2.1\ \text{inches}$

Key length based on compression, $L = \dfrac{4T}{s_c\,t\,D} = \dfrac{4(63000)}{30000(1)(4)} = 2.1$

Therefore, use L = 2.1 inches

52. Which of the following are the compositions of stainless steel 302?
a) 18 % chromium and 8 % nickel b) 18 % nickel and 8 % chromium
c) 18 % chromium and 8 % phosphor bronze d) 18 % bronze and 8 % vanadium

Answer: a) 18 % chromium and 8 % nickel

53. The root diameter of a double square thread is 0.55 inch. The screw has a pitch of 0.2 inch. Find the number of thread per inch.
a) 0.2 threads/inch b) 10 threads/inch c) 5 threads/inch d) 2.5 threads/inch

Answer: TPI = 5 threads per inch

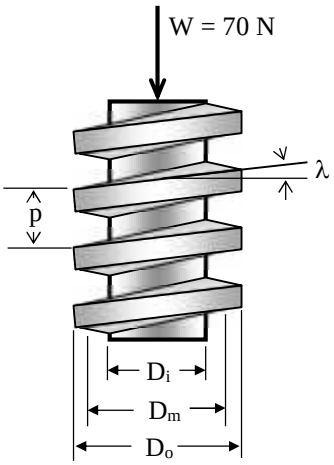
Solution:

The number of threads per inch, $\text{TPI} = \dfrac{1}{\text{p}} = \dfrac{1}{0.2} = 5 \text{ threads / inch}$

54. A single square thread power screw is to raise a load of 70 kN. The screw has a major diameter of 36 mm and a pitch of 6 mm. The coefficient of thread friction and collar friction are 0.13 and 0.10 respectively. If the collar mean diameter is 90 mm and the screw turns at 60 rpm, find the combined efficiency of the screw and collar.
a) 15.32 % b) 12.53 % c) 13.52 % d) 15.97 %

Answer: b) 12.53 %

Solution: For the depth of the thread, $\text{h} = \left(\dfrac{1}{2}\right)\text{p} = \left(\dfrac{1}{2}\right)(6) = 3\,\text{mm}$



For the mean diameter of the screw, $\text{D}_\text{m} = \text{D}_\text{o} - \text{h} = 36 - 3 = 33 \text{ mm}$

For the lead angle, $\lambda = \tan^{-1}\left(\dfrac{\text{L}}{\pi \text{D}_\text{m}}\right) = \tan^{-1}\left(\dfrac{\text{p}}{\pi \text{D}_\text{m}}\right) = \tan^{-1}\left(\dfrac{6}{33\pi}\right) = 3.3123^\text{o}$

Solving for the Efficiency, $\text{e} = \dfrac{\tan\lambda(1 - \text{f}\tan\lambda)(100\ \%)}{\tan\lambda + \text{f} + \left(\dfrac{\text{f}_\text{c}\text{D}_\text{c}}{\text{D}_\text{m}}\right)(1 - \text{f}\tan\lambda)}$

$$\text{e} = \frac{\left(\tan 3.3125^\text{o}\right)\left(1 - 0.13\tan 3.3125^\text{o}\right)(100\ \%)}{\tan 3.3125^\text{o} + 0.10 + \left[\dfrac{0.10(90)}{33}\right]\left(1 - 0.13\tan 3.3125^\text{o}\right)} = 12.53\ \%$$

55. Determine the power capacity of a cone clutch under uniform pressure and assuming the following conditions: major diameter = 250 mm; minor diameter = 200 mm; length of conical elements in contact = 125 mm; rotational speed = 870 rpm; coefficient of friction = 0.30; and allowable pressure = 70 kPa.
a) 25.74 Hp b) 24.75 Hp c) 27.45 Hp d) 24.57 Hp

Answer: a) 25.74 Hp

Solution: Friction radius, $\text{r}_\text{f} = \dfrac{2}{3}\left(\dfrac{\text{r}_\text{o}^3 - \text{r}_\text{i}^3}{\text{r}_\text{o}^2 - \text{r}_\text{i}^2}\right) = \left(\dfrac{2}{3}\right)\left[\dfrac{(125)^3 - (100)^3}{(125)^2 - (100)^2}\right] = 112.96 \text{ mm}$

Surface Area of contact, $\text{A}_\text{f} = 2\pi \text{r}_\text{f}\,\text{b} = 2\pi(0.11296)(0.125) = 0.0887 \text{ m}^2$

Force normal to the surface of contact, $\text{F}_\text{n} = \text{pA}_\text{f} = (70)(0.0887) = 6.209 \text{ kN}$

Power Capacity, $\text{P} = \dfrac{\pi\,\text{n}\,\text{T}_\text{f}}{30} = \dfrac{\pi\,\text{n}}{30}(\text{f}\ \text{F}_\text{n}\,\text{r}_\text{f}) = \dfrac{\pi(870)}{30}(0.30)(6.209)(0.11296) = 19.2 \text{ kW} = 25.74 \text{ Hp}$

56. Three extension springs are hooked in series that support a single weight of 100 kg. The first spring is rated at 4 kN/m and the other two springs are rated 6 kN/m each. Determine the equivalent stiffness of the three springs.
a) 1.71 kN/m b) 5 kN/m c) 2.71 kN/m d) 3.71 kN/m

Answer: a) 1.71 kN/m

Solution: $\frac{1}{k_e}=\frac{1}{k_1}+\frac{1}{k_2}+\frac{1}{k_3}=\frac{1}{4}+\frac{1}{6}+\frac{1}{6}=\frac{1}{4}+\frac{1}{3}=\frac{3+4}{12}=\frac{7}{12}$ $\quad k_e=\frac{12}{7}=1.71\ \text{kN/m}$

57. These springs are made from one or more flat strips of brass, bronze, steel or other materials loaded as cantilevers or simple beam.
    a) Torsion springs b) Leaf springs
    c) Garter springs d) Drawbar springs

    Answer: b) Leaf Springs

58. A flat belt is 6 inches wide and 1/3 inch thick and transmits 20 Hp. The center distance is 8 ft. The driving pulley is 6 inches in diameter and rotates at 2 000 rpm such that the loose side of the belt is on top. The driven pulley is 18 inches in diameter. The belt material is 0.035 lb/in^3 and the coefficient of friction is 0.30. Determine the belt net tension.
    a) 201 lb b) 210 lb c) 102 lb d) 120 lb

    Answer: b) 210 lb

    Solution: $F=F_1-F_2=\frac{2T}{D}=\frac{2}{D}\left(\frac{63\,000\ \text{Hp}}{n}\right)=\left(\frac{2}{6}\right)\left[\frac{63\,000(20)}{2\,000}\right]=210\ \text{lb}$

    Other Solution: $V_m=\pi D n=\pi\left(\frac{6}{12}\right)(2\,000)=3141.59\ \text{fpm}$

    $F=F_1-F_2=\frac{33\,000\,\text{Hp}}{V_m}=\frac{33\,000(20)}{3141.59}=210\ \text{lb}$

59. A pulley 600 mm in diameter transmits 40 kW at 500 rpm. The arc of contact between the belt and pulley is 155º, the coefficient of friction between belt and pulley is 0.35 and the safe working stress of the belt is 2.1 MPa. Determine the belt tensions ratio, neglecting the effect of centrifugal force.
    a) 2.578 b) 2.857 c) 5.287 d) 5.782

    Solution: $\frac{F_1}{F_2}=e^{f\theta}=(e)^{0.35(155)\left(\frac{\pi}{180}\right)}=2.578$

    Answer: a) 2.578

60. This refers to the space between adjacent coils when the spring is compressed to its operating length.
    a) Coil clearance b) Pitch c) Lead d) Deflection

    Answer: a) Coil clearance

61. Select a deep-groove ball bearing to carry a radial load F_x = 800 lb and a thrust load F_z = 700 lb at 1750 rpm. The service is 8 hr/day, but it is not continuous; design for 20 000 hr. The operation is smooth with little vibration; the outer ring rotates. Determine the design life in mr with no more than 10 % failure.
    a) 20100 mr b) 2100 mr c) 2001 mr d) 1200 mr

    Answer: b) 2100 mr

    Solution: $B_{10}=(\text{Hrs})(60\ \text{min s/hr})(\text{rpm})=\frac{(20\,000)(60)(1750)}{10^6}=2100\ \text{mr}$

62. Determine the Hp lost when a collar is loaded with 2000 lb, rotates at 50 rpm, and has a coefficient of friction of 0.15. The outside diameter of the collar is 4 inches and the inside diameter is 2 inches.
    a) 0.7314 Hp b) 0.3714 Hp c) 0.4713 Hp d) 0.4371 Hp

    Answer: b) 0.3714 Hp

Solution: $fHp = \dfrac{T_f\, n}{63000} = \dfrac{f\, W\, r_f\, n}{63000} = \dfrac{0.15(2000\ \text{lb})(1.56\,\text{inches})(50\ \text{rpm})}{63000} = 0.3714$

$$\text{Where,}\quad r_f = \frac{2}{3}\left(\frac{r_o^3 - r_i^3}{r_o^2 - r_i^2}\right) = \frac{2}{3}\left[\frac{(2)^3 - (1)^3}{(3)^2 - (1)^2}\right] = 1.56\ \text{inches}$$

63. In a lathe machine, it is the diameter of the largest workpiece it can rotate in a chuck or between centers without hitting the bed.
a) Chuck diameter b) Swing c) Distance between centers d) Spindle diameter

Answer: b) Swing

64. What load in N must be applied to a 25 mm round steel bar 2.5 m long (E = 207 Gpa) to stretch the bar 1.3 mm?
a) 42 000 N b) 52 840 N c) 53 000 N d) 60 000 N

Answer: b) The load, 52 840 N

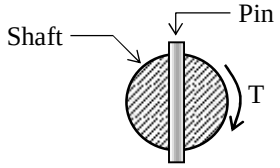
Solution: The load,

$$F = \frac{\delta A E}{L} = \frac{\delta}{L}\left(\frac{\pi}{4}\right)D^2 E = \left[\frac{1.3}{2.5(1000)}\right]\left(\frac{\pi}{4}\right)(0.025)^2\,(207\,000\,000\,000) = 52\,837.66\ \text{N}$$

65. This is a general term that refers to the mating of cylindrical parts such as bolt or a hole; it is used only when the internal member is smaller that the external member. How do you call this?
a) Clearance b) Interference c) Allowance d) Tolerance

Answer: a) Clearance

66. A 50-mm diameter shaft is to transmit 12 kW power at a speed of 500 rpm, determine the mean diameter of the pin, under double shear, for a material having a safe unit stress of 40 N/mm^2.
a) 11.08 mm b) 12.08 mm c) 13.08 mm d) 10.08 mm



Answer: b) Diameter of the pin = 12.08 mm

Solution: Transmitted Torque, $T = \dfrac{30P}{\pi n} = \dfrac{30(12\,000)}{\pi(500)} = 229.183\ \text{N}\cdot\text{m} = 229183\ \text{N}\cdot\text{mm}$

Pin Shearing Force, $F_s = \dfrac{2T}{D} = \dfrac{2(229183)}{50} = 9167.32\ \text{N}$

Pin Mean Diameter, $s_s = \dfrac{F_s}{2A_s} = \dfrac{4F_s}{2\pi d^2} = \dfrac{2F_s}{\pi d^2}$

$$d = \sqrt{\frac{2F_s}{\pi s_s}} = \sqrt{\frac{2(9167.32)}{\pi(40)}} = 12.08\ \text{mm}$$

67. This is a lubrication condition where non-conformal surfaces are completely separated by lubricant film and no asperities are in contact. How do you call this lubrication condition?
a) Elastohydrodynamic lubrication b) Boundary lubrication
c) Hydrodynamic lubrication d) Hydrostatic lubrication

Answer: a) Elastohydodynamic lubrication

68. A 1200 mm cast iron pulley is fastened to 112.5 mm shaft by means of a 28.13 mm square key 175 mm long. The key and shaft have a shearing stress of 14 000 psi. Determine the force acting at the pulley that will shear the key.
a) 10 015 lb b) 11 005 lb c) 11 050 lb d) 10 501 lb

Answer: a) The force acting on the pulley = 10 015 lb

Solution: $$F_p = \frac{2T}{D_p} = \frac{2\left(\frac{s_s bLD}{2}\right)}{D_p} = s_s bL\left(\frac{D}{D_p}\right) = (14\,000)\left(\frac{28.13}{25.4}\right)\left(\frac{175}{25.4}\right)\left(\frac{112.5}{1200}\right) = 10\,014.74 \text{ lb}$$

Where, $T = \frac{s_s bLD}{2}$ $\rightarrow$ Torque based on shear, $\text{in} \cdot \text{lb}$

69. A 75-mm diameter shaft is transmitting 350 kW at 650 rpm. A flange coupling is used and has 6 bolts, each 18 mm in diameter. Find the required diameter of the bolts circle based on an average shearing stress of 27.5 MPa.
a) 245 mm b) 254 mm c) 452 mm d) 425 mm

Answer: a) Bolt Circle diameter = 245 mm

Solution: $$D_B = \frac{8T}{\pi s_s d^2 n_B} = \frac{8(30)P}{\pi^2 d^2 s_s n\, n_B} = \frac{8(30)(350)}{\pi^2 (0.018)^2 (27\,500)(650)(6)} = 0.245 \text{ m} = 245 \text{ mm}$$

Note: Torque Based on Shear, $T = \frac{\pi s_s d^2 D_B n\, n_B}{8} = \frac{30P}{\pi n}$

70. How do you call the flattened end of a shank, and intended to fit into a driving slot in the socket?
a) Handle b) Tang c) Relief d) Tip

Answer: b) Tang

71. If a sleeve bearing has an outside diameter of 38.1 mm and a length of 50.8 mm, the wall thickness is 3/16 inch. The bearing is subjected to a radial load of 500 kg. What is the bearing pressure, in psi?
a) 904 psi b) 409 psi c) 490 psi d) 940 psi

Answer: c) Bearing pressure = 490 psi

Solution: For bearing or projected area, $$A_B = LD = \left(\frac{50.8}{25.4} \text{ in.}\right)\left[\frac{38.1}{25.4} \text{ in.} - 2\left(\frac{3}{16}\right) \text{in}\right] = 2.25 \text{ in}^2$$

Bearing pressure, $$p = \frac{W}{A_B} = \frac{(500 \text{ kg})(2.205 \text{ lb/kg})}{2.25 \text{ in}^2} = 490 \text{ psi}$$

72. This material is the most popular alloy spring steel for conditions involving higher stresses than can be used with the high-carbon steels and for use where fatigue resistance and long endurance are needed; this is also good for shock and impact loads.
a) Chrome silicon b) Chrome vanadium c) hard-drawn wire d) Oil-tempered wire

Answer: b) Chrome Vanadium

73. Determine the minimum whole depth of spur gear of 14.5° involute type with diametral pitch of 24 and circular pitch of 0.1309 inch.
a) 0.09000 inch b) 0.08900 inch c) 0.0899 inch d) 0.089758 inch

Answer: c) Whole depth = 0.0899 inch

Solution: From Vallance, page 262: $$h = \frac{2.157}{p_d} = \frac{2.157}{24} = 0.089875 \text{ inch}$$

74. A parallel helical gear set was a 17-tooth pinion driving a 34-tooth gear. The pinion has a right-hand helix angle of 30°, a normal pressure angle of 20°, and a normal diametral pitch of 5 teeth/in. Find the axial circular pitches.
a) 1.2566 inches/tooth b) 1.6625 inches/tooth c) 1.6526 inches/tooth d) 1.6256 inches/tooth

Answer: a) Axial circular pitch = 1.2566 inches/tooth

Solution: $P_c = \frac{P_{cn}}{\cos\psi} = \frac{0.62832}{\cos 30^o} = 0.72552 \text{ inch/tooth}$

$$P_a = \frac{P_c}{\tan\psi} = \frac{0.72552}{\tan 30^o} = 1.2566 \text{ inches/tooth}$$

75. For an American Standard Screw Threads, what does 6-32 UNC designate?
a) Size 6, 32 threads per inch, coarse thread b) 6 inches basic diameter, 32 threads per inch, coarse thread
c) Size 6, 32 threads per inch, fine thread d) 32 inches basic diameter, 6 threads per inch, coarse thread

Answer: a) Size 6, 32 threads per inch, coarse thread

- Note: 6 stands for the designated size, 32 stands for the number of threads per inch, UNC stands for Coarse threads

76. Determine the Poisson's ratio of a material whose modulus of elasticity is 200 GPa and whose modulus of rigidity is 80 GPa.
a) 0.33 b) 0.25 c) 0.38 d) 0.22

Answer: b) Poisson's ratio = 0.25

Solution: $G = \frac{E}{2(1+\nu)}$ E = 200GPa, G = 80GPa: $\therefore \neg = 0.25$

77. A steel has a BHN = 300. What is its approximate ultimate strength in ksi?
a) 300 ksi b) 150 ksi c) 75 ksi d) 200 ksi

Answer: b) Ultimate Strength = 150 ksi

Solution: $S_u \approx 0.5(BHN)$, ksi

78. If the angular deformation of a solid shaft should not to exceed 1° in a length of 1.8 m and the allowable shearing stress is 83 MMa, what is the diameter of the shaft? Assume that the shaft material has G = 77 x 10^6 kPa.
a) 222.34 mm b) 234.22 mm c) 23.42 cm d) 24.22 cm

Answer: a) Shaft diameter = 222.34 mm

Solution: $\theta = \frac{TL}{JG} = \frac{32TL}{\pi D^4 G} = \frac{32\left(\frac{\pi D^3 s_s}{16}\right)L}{\pi D^4 G} = \frac{2s_s L}{DG}$ $D = \frac{2s_s L}{\theta G} = \frac{2(83000)(1.8)}{1^o\left(\frac{\pi}{180^o}\right)(77 \text{ x } 10^6)} = 222.34 \text{ mm}$

79. How do you call the process of producing the residual compressive stress of machine parts, which is performed by directing the a high velocity stream of hardened balls or pellets at the surface to be treated.
a) Nitriding b) Shot blasting c) Peening d) Tempering

Answer: b) Shot blasting

80. Determine the Hp lost when a collar is loaded with 2000 lb, rotates at 50 rpm, and has a coefficient of friction of 0.15. The outside diameter of the collar is 4 inches and the inside diameter is 2 inches.

a) 0.7314 Hp b) 0.3714 Hp c) 0.4713 Hp d) 0.4371 Hp

Answer: b) Frictional Horsepower = 0.374 Hp

Solution: $fHp = \frac{T_f n}{63000} = \frac{f\ W\ r_f\ n}{63000} = \frac{0.15(2000\ lb)(1.56\,inches)(50\ rpm)}{63000} = 0.3714$

Where, $r_f = \frac{2}{3}\left(\frac{r_o^3 - r_i^3}{r_o^2 - r_i^2}\right) = \frac{2}{3}\left[\frac{(2)^3 - (1)^3}{(3)^2 - (1)^2}\right] = 1.56\ inches$

81. It is a process that produces residual compressive stress on the machine part, which uses a series of hammer blows on the surface.
a) Nitriding b) Shot blasting c) Peening d) Tempering

Answer: c) Peening

82. Two shafts 3.6 m between centers carry pulleys 1.2 m in diameter and 0.91 m in diameter respectively, connected by a crossed belt. It is desired to put the belt on as an open belt. How long a piece must be cut of it?
a) 303.3 mm b) 330 mm c) 333.0 mm d) 330.3 mm

Answer: Length to be cut off = 303.3 mm

Solution: For the length of an open belt connection,

$$L_o = \frac{\pi}{2}(D_1 + D_2) + 2C + \frac{(D_2 - D_1)^2}{4C} = \left(\frac{\pi}{2}\right)(1200 + 910) + 2(3600) + \frac{(1200 - 910)^2}{4(3600)} = 10\,520.22\ mm$$

For the length of belt for crossed belt connection,

$$L_c = \frac{\pi}{2}(D_1 + D_2) + 2C + \frac{(D_2 - D_1)^2}{4C} = \left(\frac{\pi}{2}\right)(1200 + 910) + 2(3600) + \frac{(1200 + 910)^2}{4(3600)} = 10823.55\ mm$$

Solving for the difference of lengths,

$$\Delta L = L_c - L_o = 10\,823.55 - 10\,520.22 = 303.33\ mm$$

83. It is a surface-hardening process for alloy steels in which the material is heated to 950 °F in a nitrogen atmosphere, typically ammonia gas, followed by slow cooling.
a) Quenching b) Nitriding c) Shot blasting d) Peening

Answer: b) Nitriding

84. A 20-tooth motor sprocket, running at 1200 rpm, drives a blower at a speed ratio of 4:1. Using the largest permissible chain size and the largest permissible center distance of 80 pitches, what length of chain in pitches is required to connect the sprockets?
a) 200 pitches b) 212 pitches c) 216 pitches d) 220 pitches

Answer: b) Chain length = 21 pitches

Solution: $L_c = \frac{N_{t1} + N_{t2}}{2} + 2C_p + \frac{(N_{t2} - N_{t1})^2}{40C_p} = 212.pitches$

85. Which of the following gases is typically used in nitriding process of surface hardening?
a) Nitrogen gas b) Carbon dioxide c) Ammonia gas d) Hydrogen gas

Answer: c) Ammonia gas

86. A 20-kW motor, running at 1200 rpm, drives a 400 mm diameter pulley at a belt tension ratio of 2.4. If the belt's tight side tension is only 1200 N, determine the transmission efficiency.
a) 87.97 % b) 84.58 % c) 85.66 % d) 86.55 %

Answer: a) Transmission Efficiency = 87.97 %

Solution: $\eta = \dfrac{P_{output}}{P_{input}} = \dfrac{\dfrac{T_{out}(\pi n)}{30}}{P_{input}} = \dfrac{\left(\dfrac{\pi n}{30}\right)\left(\dfrac{D}{2}\right)F_{net}}{P_{input}} = \dfrac{\left(\dfrac{\pi n}{30}\right)\left(\dfrac{D}{2}\right)(F_1 - F_2)}{P_{input}} = \dfrac{\left(\dfrac{1200\pi}{30}\right)\left(\dfrac{0.40}{2}\right)\left(1200 - \dfrac{1200}{2.4}\right)}{20000} = 0.8797$

87. A right-handed single-thread hardened-steel worm has a catalog rating of 2.25 kW at 650 rpm when meshed with a 48-tooth cast-steel gear. The axial pitch of the worm is 25 mm, normal pressure angle is 14.5°, and the pitch diameter of the worm is 100 mm. The coefficient of friction is 0.085. Determine the shafts center distance.
a) 241 mm b) 142 mm c) 412 mm d) 124 mm

Answer: a) Center distance = 241 mm

Solution: $\text{Speed Ratio, } SR = \dfrac{\omega_w}{\omega_g} = \dfrac{n_w}{n_g} = \dfrac{T_g}{T_w} = \dfrac{D_g \cos\lambda}{D_w \sin\lambda} = \dfrac{D_g}{D_w \tan\lambda}$

$\text{Tan}\lambda = \dfrac{L}{\pi D_w} = \dfrac{p}{\pi D_w} = \dfrac{25}{\pi(100)} = 0.07958 \quad \rightarrow \quad \lambda = 4.55^o$

Pitch diameter of the gear, $D_g = \left(\dfrac{T_g}{T_w}\right) D_w \tan\lambda = \left(\dfrac{T_g}{T_w}\right) D_w \left(\dfrac{p}{\pi D_w}\right) = \left(\dfrac{T_g}{T_w}\right)\left(\dfrac{p}{\pi}\right) = \left(\dfrac{48}{1}\right)\left(\dfrac{25}{\pi}\right) = 381.97 \text{ mm}$

Center Distance, $C = \dfrac{D_w + D_g}{2} = \dfrac{100 + 381.97}{2} = 241 \text{ mm}$

88. Which of the following is the benefit in using nitriding as a surface-hardening process for alloy steels?
a) Improvement of endurance strength, 50 % or more
b) Improvement of endurance strength, less than 50 %
c) Improvement of endurance strength, more than 50 %
d) 80 % improvement on the endurance strenght

Answer: a) Improvement of endurance strength, 50 % or more

89. A 20° straight-tooth bevel pinion having 14 teeth and a diametral pitch of 6 teeth/inch drives a 42-tooth gear. The two shafts are at right angles and in the same plane. Find the pitch angle of the pinion.
a) 18.4° b) 20° c) 14.5° d) 20.5°

Answer: a) Pitch angle = 18.4°

Solution: $\gamma = \tan^{-1}\left(\dfrac{T_p}{T_g}\right) = \tan^{-1}\left(\dfrac{14}{42}\right) = 18.4^o$

90. A triple-thread worm has a lead angle of 17° and a pitch diameter of 2.2802 inches. Find the center distance when the worm is mated with a wheel of 48 teeth.
a) 6.72 inches b) 7.26 inches c) 6.27 inches d) 7.62 inches

Answer: a) Center Distance = 6.72 inches

Solution: $D_g = \left(\dfrac{T_g}{T_w}\right) D_w \tan\lambda = \left(\dfrac{48}{3}\right)(2.2802)\tan 17^o = 11.154 \text{ inches}$

$C = \dfrac{D_w + D_g}{2} = \dfrac{2.2802 + 11.154}{2} = 6.72 \text{ inches}$

91. A double-thread worm has a pitch diameter of 3 inches. The wheel has 20 teeth and a pitch diameter of 5 inches. Find the gear helix angle.
a) 4.69° b) 9.46° c) 6.49° d) 6.94°

Answer: b) Gear helix angle = 9.46°

Solution: $\lambda = \tan^{-1}\left[\left(\frac{T_w}{Tg}\right)\left(\frac{D_g}{D_w}\right)\right] = \tan^{-1}\left[\frac{2}{20}\left(\frac{5}{3}\right)\right] = 9.46^o$

92. A 36-tooth pinion turning at 300 rpm drives 120-tooth gear of 14.5° involute full depth pressure angle. Determine the rpm of the driven gear.
a) 60 rpm b) 45 rpm c) 75 rpm d) 90 rpm

Answer: d) 90 rpm

Solution: $n_g = n_p\left(\frac{T_p}{T_g}\right) = (300)\left(\frac{36}{120}\right) = 90 \text{ rpm}$

93. If two parallel shafts are connected by cylinders in pure rolling contact and turning in the same direction, and having a speed ratio of 2.75, what is the Center distance of the two shafts assuming that the diameter of the smaller cylinder is 22 cm?
a) 18.25 cm b) 19.25 cm c) 20.25 cm d) 17.25 cm

Answer: b) Center Distance = 19.25 cm

Solution: Diameter of the bigger cylinder, $D_2 = SR(D_1) = 2.75(22) = 60.5 \text{ cm}$

Center distance, $C = \frac{D_2 - D_1}{2} = \frac{60.5 - 22}{2} = 19.25 \text{ cm}$

94. In estimating the actual endurance strength of steel parts, one of the factors to be considered is the material factor, which of the following is the recommended material factor for cast steel?
a) 0.70 b) 0.80 c) 0.75 d) 1.0

Answer: a) Material factor for cast steel = 0.70

95. How do you call the level of stress that the part will be permitted to see under operating conditions?
a) Yield stress b) Endurance stress c) Design stress d) Ultimate stress

Answer; c) Design Stress

96. Which of the following column formulas is applicable to cast iron columns?
a) Euler's formula b) J.B.Johnson's formula
d) Secant formula d) Straight line formula

Answer: d) Straight line formula

- Ans. D. Straight line formula. Cast iron columns are usually designed on the basis of
$\frac{P}{A} = 9000 - 40\left[\frac{L_e}{k}\right] \rightarrow$ a Straight line formula
- Where the slenderness ratio Le/k should not exceed 70.

97. Which of the following ferrous metals has the lowest carbon content?
a) Carbon steel b) Wrought iron c) Cast iron d) SAE 4140

Answer: b) Wrought iron

- Wrought iron usually contains less than 0.04% C; steel usually has less than 2.5% C; cast iron has more than 1.7% C; SAE 4140 has approximately 0.4% C.

98. Two extension coil springs are hooked in series that support a single weight of 100 kg. The first spring is rated at 4 kN/m and the other spring is rated at 6 kN/m. Determine the total deflection of the springs.
a) 408.6 mm b) 486.0 mm c) 480.6 mm d) 460.8 mm

Answer: a) Spring Deflection = 408.6 mm

Solution: $\delta_t = \delta_1 + \delta_2 = \frac{F}{k_1} + \frac{F}{k_2} = F\left(\frac{k_1 + k_2}{k_1 k_2}\right) = (100\text{ kg})(9.8066\text{ N/kg})\left[\frac{4+6}{4(6)}\right] = 408.6\text{ mm}$

99. If the ultimate shear strength of a steel plates is 42 000 psi, what force is necessary to punch a 0.75 inch diameter hole in a 0.625 inch thick plate?
a) 61 850 lb b) 65 810 lb c) 61 580 lb d) 60 185 lb

Answer: a) Punching force = 61 850 lb

Solution: $F = s_u A_s = s_u(\pi d\, t) = (42000\text{ lb/in}^2)(\pi)(0.75\text{ in})(0.625\text{ in}) = 61850.1\text{ lb}$

100. If stiffness is the main criterion in selecting a material, which of the following is the most economical choice?
a) SAE 3130 b) SAE 1020 c) SAE 6150 d) AISI 301, ¼ hard stainless steel

- Ans. B. SAE 1020- plain carbon steel. All of the above materials are steel with practically equal modulus of elasticity. The three other materials are alloy steels that are relatively more expensive.

101. Which of the following materials can easily be machined?
a) AISI C1020 b) AISI C1112 c) AISI C1030 d) AISI C1010

Answer: b) AISI CIII2

- Ans. b. C1112. This is a free-cutting steel with a higher sulfur content for ease in machining

102. Wood is an _____ material; that is, its mechanical properties are unique and independent in three mutually perpendicular directions—longitudinal, radial, and tangential.
a) Isotopic b) Anisotropic c) Orthotropic d) Any of these

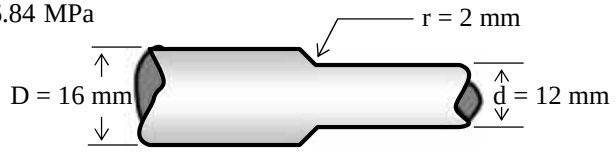
Answer: c) Orthotropic material

103. A stepped torsion shaft has diameters of 16 mm and 12 mm and a fillet radius of 2 mm. The shaft is subjected to a torque of 12.5 N-m. Find the maximum induced stress caused by the fillet. Consider a stress concentration factor of 1.25.
a) 36.84 MPaa b) 46.05 MPa c) 38.64 MPa d) 45.06 MPa

Answer: b) 46.05 MPa

Solution: Solving for the average induced shear stress in the shaft

$$s_s = \frac{16T}{\pi d^3} = \frac{16(12.5)}{\pi(0.012)^3} = 36841422.01\text{ Pa} = 36.84\text{ MPa}$$

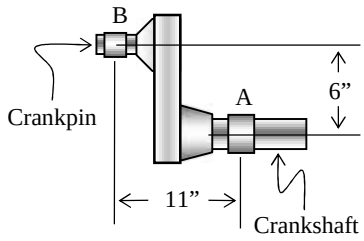


Solving for the maximum induced shear stress,

$$s_{s(\max)} = k_{ts}\, s_s = (1.25)(36.84) = 46.05\text{ MPa}$$

104. A steam engine that has a stroke of 12 inches has an overhung crank of 11 inches. The maximum tangential force, P, on the crank may be assumed as 75000 lb. Assuming an allowable stress in shear as 4400 psi, determine the crankshaft diameter.
a) 4.77 inches b) 3.77 inches c) 2.77 inches d) 1.77 inches

Answer: a) Crankshaft Diameter = 4.77 inches



Solution:

Solving for the torque, $T = P \cdot R = (7500)(6) = 45\,000 \text{ in} \cdot \text{lb}$

Solving for the bending moment, $M = (7500)(11) = 82\,500 \text{ in} \cdot \text{lb}$

Solving for the shaft diameter,

$$D = \left[\left(\frac{16}{\pi s_s} \right) \sqrt{M^2 + T^2} \right]^{\frac{1}{3}} = \left[\frac{16}{\pi (4400)} \sqrt{(45\,000)^2 + (82\,500)^2} \right]^{\frac{1}{3}} = 4.77"$$

105. The principal raw materials used in steelmaking are iron ore, coal, and _____.
a) Coke b) Limestone c) Slag d) Flux

Answer: b) Limestone

106. The steel part is heated to a temperature of 900–1150 degrees F in an atmosphere of ammonia gas and dissociated ammonia for an extended period of time that depends on the case depth desired.
a) Nitriding b) Carburizing c) Case hardening d) Cyaniding

Answer: a) Nitriding

107. Determine the Hp lost when a collar is loaded with 2000 lb, rotates at 50 rpm, and has a coefficient of friction of 0.15. The outside diameter of the collar is 4 inches and the inside diameter is 2 inches.
a) 0.7314 Hp b) 0.3714 Hp c) 0.4713 Hp d) 0.4371 Hp

Answer: b) 0.3714 Hp

Solution: $$fHp = \frac{T_f n}{63000} = \frac{f W r_f n}{63000} = \frac{0.15(2000 \text{ lb})(1.56 \text{ inches})(50 \text{ rpm})}{63000} = 0.3714$$

Where, $$r_f = \frac{2}{3}\left(\frac{r_o^3 - r_i^3}{r_o^2 - r_i^2} \right) = \frac{2}{3}\left[\frac{(2)^3 - (1)^3}{(3)^2 - (1)^2} \right] = 1.56 \text{ inches}$$

108. The primary application of high-speed steels is to tools used for the working of metals _____.
a) that are too hard b) at high cutting speeds
c) that are too soft d) at slow cutting speeds

Answer: b) At high cutting speeds

109. A parallel helical gear-set consists of a 19-tooth pinion driving a 57-teeth gear. The pinion has a left-hand helix angle of 20°, a normal pressure angle of 14½°, and a normal diametal pitch of 10 teeth/inch. If the pinion is to transmit 50 Hp at a speed of 1750 rpm. Determine the center distance of the two gears.
a) 2.02 inches b) 6.06 inches c) 4.04 inches d) 2.06 inches

Answer: c) 4.04 inches

Solution: $$P_{dn} = \frac{P_d}{\cos\psi} = \frac{T_p}{D_p \cos\psi} = \frac{T_g}{D_g \cos\psi}$$

Pitch diameter of the pinion, $D_p = \frac{T_p}{P_{dn} \cos\psi} = \frac{19}{10 \cos 20^o} = 2.02$ inches

Pitch Diameter of the gear, $D_g = D_p\left(\frac{T_g}{T_p}\right) = 2.02\left(\frac{57}{19}\right) = 6.06$ inches

Center-to-center distance, $C = \frac{D_p + Dg}{2} = \frac{2.02 + 6.06}{2} = 4.04$ inches

110. In gearing, this is the ratio of the arc of action to the circular pitch.
a) Speed ratio b) Arc ratio c) Contact ratio d) Gear ratio

Answer: c) Contact ratio

111. A single square thread power screw is to raise a load of 70 kN. The screw has a major diameter of 36 mm and a pitch of 6 mm. The coefficient of thread friction and collar friction are 0.13 and 0.10 respectively. If the collar mean diameter is 90 mm and the screw turns at 60 rpm, find the axial linear speed of the screw.
a) 5 mm/s b) 6 mm/s c) 7 mm/s d) 5.5 mm/s

Answer: b) 6 mm/s

Solution: For the linear speed of the screw,

$V_n = n\ (L) = (60\ rpm)(6\ mm/rev) = 360\ mm/min = 6\ mm/s$

112. Flywheel arms are usually of elliptical cross-section, the strength of the arms should equal _____the strength of the shaft in torsion.
a) Three-fourths b) One-half c) Two-thirds d) One-fourth

Answer: a) Three-fourth

113. This alloy *(nickel, iron, chromium, cobalt* is a non-magnetic, corrosion resistant material suitable for sub-zero temperatures and temperatures up to about 750 degrees F., provided that torsional stresses are kept below 75,000 pounds per square inch. It is precipitation-hardened to produce hardnesses of 48 to 50 Rockwell C and is used in watch and instrument springs.
a) Elinvar b) Monel c) Inconel d) Dynavar

Ans. Dynavar; source: Machinery's handbook

114. To ensure an adequate factor of safety in the design of a shaft with standard keyway, the key width should be about:
a) One half of the shaft diameter b) One fourth of the shaft diameter
c) One eighth of the shaft diameter d) One third of the shaft diameter

Answer: b) One-fourth of the shaft diameter

Note: One-fourth of shaft diameter, as a guide in key selection for both square and flat rectangular keys.

115. What is the property of matter that causes it to resist any change in its motion or state of rest?
a) Momentum b) Kinetic Energy c) Inertia d) Section modulus

Answer: c) Inertia

116. This is defined as the cutting time to reach a predetermined wear, called the tool wear criterion.
a) Wear duration b) Cycle time c) Tool life d) Life cycle

Answer: c) Tool life

117. Which of the following G-codes refers to rapid traverse in CNC machining?

a) G00 b) G01 c) G02 d) G03

Answer: a) G00

118. An acronym in CNC machining which means access of the machine operator to insert machining instructions directly into the NC machine control system via push buttons, pressure pads, knobs, or other arrangements.
a) FMS b) FMC c) CIM d) MDI

Answer: d) MDI

Note: MDI = manual data input

119. The variable polarity plasma arc (VPPA) process was developed for welding metals that form an oxide skin, such as _____.
a) Steel b) Copper c) Cast iron d) Aluminum

Answer: d) Aluminum

120. Which of the following statements is NOT true?
a) The terms "polishing" and "buffing" are sometimes applied to similar classes of work in different plants.
b) Polishing is any operation performed with wheels having abrasive glued to the working surfaces
c) Buffing is done with wheels having the abrasive applied loosely
d) Polishing is not so harsh an operation as buffing, and it is commonly utilized to obtain very fine surfaces having a "grainless finish."

Answer: d)

Note: Polishing is harsher than buffing.

121. If the steel is strongly deoxidized by the addition of deoxidizing elements, no gas is evolved, and the steel is technically called _____because it lies quietly in the molds.
a) Quenched b) Annealed c) Killed d) Tempered

Answer: c) Killed steel

122. Stainless steels generally contain at least __ per cent chromium, with or without other elements.
a) 18 b) 16 c) 12 d) 10

Answer: d) 10 percent

123. What grades of stainless steels are nonmagnetic in the annealed condition, although some may become slightly magnetic after cold working?
a) Ferritic grades b) Austenitic grades c) Martensitic grades d) Any of these

Answer: b) Austenitic grades

124. These steels (SAE Steels 1006, 1008, 1010, 1015) are the lowest carbon steels of the plain carbon type, and are selected where _____ is the primary requisite of the user.
a) Strength b) Cold formability c) Ductility d) Durability

Answer: b) Cold formability

125. Steel is heated to a temperature above the critical range, after which it is cooled in still air to produce a generally fine pearlite structure. The purpose is to promote uniformity of structure and properties after a hot-working operation such as forging or extrusion. What was the heat treatment involved?
a) Annealing b) Normalizing c) Tempering d) Stress relieving

Answer: b) Normalizing

126. At certain speeds called the critical speeds, a rotating shaft will become dynamically unstable and the resulting vibrations and deflections can result in damage not only to the shaft but to the machine of which it is a part. At what percentage of the critical speed should a shaft be safely operated?
a) Plus or minus 20% b) Plus or minus 5 % c) Plus or minus 10 % d) Any of these

Answer: a) Plus or minus 20 %

127. This is the most widely used of all spring materials for small springs operating at temperatures up to about 250 degrees F. It is tough, has a high tensile strength, and can withstand high stresses under repeated loading.
a) Music wire b) Hard drawn spring wire
c) Oil tempered spring wire d) Stainless steel spring wire

128. It is an acronym in machining. This process uses an electrode to remove metal from a workpiece by generating electric sparks between conducting surfaces.
a) MIG b) GMAW c) EDM d) CNC

Ans. Electro-Discharge Machining (Source: Machinery's Handbook)

129. In die casting accurate parts made of steel, what shrinkage allowance in inches per inch is recommended?
a) 0.011 b) 0.022 c) 0.033 d) 0.044

Ans. 0.022. (Source: Machinery's Handbook)

130. This are gears used to connect shafts that are non-intersecting and non-parallel. They are a cross between spriral bevel gears and worm gears.
a) Helical gears b) **Hypoid gears** c) Planetary gears d) Bevel gears

131. This is a type of seal used where some form of relative motion occurs between rigid parts of an assembly.
a) Gasket b) Distorted seal c) Vibratory seal d) **Dynamic seal**

132. It is a lubrication for roller chains wherein the lubricant is supplied by a circulating pump capable of supplying the chain drive with a continuous flow of oil inside the chain loop evenly across the chain width and directly at the slack strand.
a) **Oil stream lubrication** b) Bath lubrication
c) Drip lubrication d) Recirculated lubrication

133. In manufacturing, this is the operation of cutting out flat area to some desired shape and is usually the first step in a series of operation.
a) Turning b) Facing c) **Blanking** d) Finishing

134. An M-code which generally refers to start spindle rotation in a clockwise direction.
a) **M03** b) M04 c) M05 d) M06

Ans. M03-spindle start in a clockwise rotation

135. A final operation to improve the polish of a metal and to bring out the maximum luster
a) Finishing b) Surface grinding c) Broaching d) **Buffing**

136. Machining operations with the proper application of a cutting fluid generally has the following attributes except:
a) Higher cutting speeds b) Higher feed rates
c) Lengthened tool life d) H**igher cutting accuracy**

Ans. D. The use of cutting fluids does not increase cutting accuracy.

137. A material of construction (only developed commercially in the late 1940's concurrently with zirconium) offers the unique combination of wide ranging corrosion resistance, low density, and high strength.
a) Tungsten b) **Titanium** c) Vanadium d) Molybdenum

138. Which of the following is the lightest of all structural metals?
a) Aluminum b) Copper c) **Magnesium** d) Manganese

139. This process reduces internal stresses, caused by machining, cold working, or welding, by heating the steel to a temperature below the critical range and holding it there long enough to equalize the temperature throughout the piece.
a) Annealing b) Normalizing c) Tempering d) **Stress Relieving**

140. A free-cutting steel has a higher _____ content than comparable carbon steels.
a) **Sulfur** b) Cobalt c) Nickel d) Chromium

141. This property designates the steels resistance to the softening effect of elevated temperature.
a) **Hot hardness** b) Machinability c) Toughness d) Elasticity

142. Use of hard solders, silver solders and smelter solders which have silver, copper, or nickel bases and have melting points above 800 degrees F is known as_____
a) Soldering b) Welding c) **Brazing** d) Any of these

143. In braking, the term backstop refers to a brake that is:
a) **Self locking in one direction** b) Self energizing
c) Self locking in both directions d) Any of these

Ans. Self-locking in one direction only

144. How do you call a fixed crane consisting of a supported vertical member from which extends a horizontal swinging arm carrying a trolley hoist or other hoisting mechanism?
a) **Jib crane** b) Gantry crane c) Overhead crane d) Tower crane

Ans. a) Jib crane (source: PME Code)

145. This iron is also known as a ductile cast iron. How do you call this iron?
a) Malleable iron b) **Nodular cast iron** c) White cast iron d) Gray cast iron

Ans. b) Nodular cast iron is a ductile cast iron.

146. It is the ability to deform plastically to compensate for irregularities in bearing assembly. How do you call this?
a) Plasticity b) **Conformability** c) Embeddability d) Elasticity

147. A material of construction (only developed commercially in the late 1940's concurrently with zirconium) offers the unique combination of wide ranging corrosion resistance, low density, and high strength.
a) **Titanium** b) Tungsten c) Vanadium d) Molybdenum

148. Newton's law of motion that describes that if a force acts to change the state of motion of the body, the body offers a resistance equal and directly opposite to the force.
a) Second law b) **Third law** c) First law d) Universal gravitation

Ans. b) Newton's third law of motion: Action = Reaction

149. These are steels most widely used of engineering materials. No other material offers comparable versatility for product design.
a) **Wrought steels** b) Low carbon steels c) Medium carbon steels d) Tool steels

150. Which of the following steels does not readily respond to heat treatment?
a) SAE 1045 b) AISI 6150 c) **SAE 1020** d) SAE 1095

- Low carbon steels (0.3% C and lower) do not readily respond to heat treatment.

151. What is an element added to steel to improve its machinability?
a) Carbon b) **Sulfur** c) Cobalt d) Chromium

- Free machining or free cutting carbon contains more sulfur than other steels.

152. Which of the following information is FALSE regarding steel that has increased carbon content?
a) Its strength is increased b) Its BHN becomes greater
c) **Its ductility is improved** d) Its % reduction or elongation is reduced

- The ductility of steel is reduced if its carbon content is increased.

153. In manufacturing, what is the operation of cutting out flat area to some desired shape and is usually the first step in a series of operation?
a) Turning b) **Blanking** c) Facing d) Finishing

Ans. b) Blanking (Source: PME Code)

154. This is a metal joining process which uses a non-ferrous filler metal with a melting point below that of the base metals but above 800°F. How do you call this process?
a) **Brazing** b) Arc welding c) Soldering d) Riveting

155. Rivet holes are made usually ____ inch larger in diameter than the nominal diameter of the rivet.
a) 1/8 **b) 1/16** c) ¼ d) 1/32

- Generally 1/16" from MD books (e.g. Black) and from the Machinery's Handbook.

156. Which of the following equations/formulas does not belong to the group?
a) **Lame's equation** b) Euler's formula c) J. B. Johnson's equation d) Secant formula

- Lame's equation is an equation for a thick-walled pressure cylinder. The other 3 are for columns.

157. In CNC programming, which of the following G code commands is for dwell or rest?
a) G01 b) **G04** c) G03 d) G02

- G04 is for dwell or rest; G01 is for linear interpolation; G02 is for circular interpolation CW; G03 is for circular interpolation CCW.

158. In CNC programming, which of the following M code commands is for a tool change?
a) **M06** b) M04 c) M03 d) M10

- M06 is for a tool change; M03 is for spindle start CW; M04 is for spindle start CCW; M10 is for chuck open.

159. Which of the following is a material description referring to unique properties in three mutually perpendicular planes?
a) Isotropy b) Anisotropy c) **Orthotropy** d) Isometry

Ans. Orthotropy. Example is wood which shows unique properties in the three mutually perpendicular planes.

160. The true stress-strain curve in a stress-stress diagram appears to be:
a) Lower than the engineering stress-strain curve
b) **Higher than the engineering stress-strain curve**
c) The same as the engineering stress strain curve
d) Symmetrical with the engineering stress-strain curve

- The true stress-strain curve uses the actual area of the specimen and is therefore higher than the engineering curve which is based on a constant (original) area of the specimen.

161. This is a hardening treatment for steels having low carbon content.
a) Tempering b) **Case hardening** c) Normalizing d) Anodizing

162. What is a manufacturing process used for the production of aluminum?
a) Forging b) **Extrusion** c) Blow molding d) Injection molding

163. This refers to a loss of material from the interface of two metal surfaces that are in intimate contact. How do you call this?
a) Interfacing b) Interference c) Wear d) **Fretting corrosion**

164. This is a type of fit that requires heating the hub to expand its inside diameter. What do you call this type of fit?
a) Expansion fit b) Force fit c) **Shrink fit** d) Any of these

165. AFBMA is an acronym for an association involved in what machine elements?
a) **Ball and roller bearings** b) Journal bearings
c) Flat belts and other belt types d) Any type of gears

- AFBMA means Anti-Friction Bearing Manufacturers' Association and is concerned with rolling element bearings such as ball, roller, and needle bearings.

166. What is the general description for mild steel?
a) Medium carbon steel b) **Low carbon steel** c) High carbon steel d) Cold rolled steel

Ans. Mild carbon steels are low carbon steels.

167. Von Mises theory is the other term used for
a) Maximum principal stress theory **b) Octahedral shear-stress theory**
c) Maximum shear-stress theory d) Energy distortion theory

168. A type of key in which width and thickness are equal is called as:
a) Flat key **b) Square key** c) Pin key d) Barth key

169. In the design of key, the typical hub lengths are in accordance with the following relation where D is shaft diameter.
a) 1.25D to 2.4D b) 0.5D to 1.25D c) 2.4D to 3.5D d) Depends on shaft diameter

170. A coupling that allows axial flexibility/movement in the operation. Made of alternate bolting of steel, leather, fabric and/or plastic material into two flanges.
a) Flexible disk coupling b) Flexible toroidal spring coupling
c) Flexible Oldham coupling d) Elastic material bonded coupling

171. It is a machine member that supports another part that rotates, slides, or oscillates in or on it.
a) Pulley b) Key **c) Bearing** d) Shaft

172. It is a bearing that permits constrained relative motion of rigid parts; lubricant is generally inserted or supplied between the mating surfaces to reduce friction and wear, and to carry away the heat generated.
a) Sliding Contact Bearing b) Rolling Contact Bearing
c) Thrust Bearing d) Journal Bearing

173. These are surfaces that do not conform to each other very well as in the rolling-element bearings.
a) Conformal surfaces **b) Non-conformal surfaces**
c) Sliding surfaces d) Rolling surfaces

174. The study of lubrication, friction, and wear of moving or stationary parts is known as:
a) Lubrication **b) Tribology** c) Hydrodynamics d) Hydrostatics

175. A bearing where surfaces are non-conformed and motion is primarily rolling; it composed of rolling elements interposed between an outer ring and inner ring.
a) Sliding-element bearing **b) Rolling-element bearing**
c) Conformal surfaces bearing d) Non-conformal surfaces bearing

176. In a straight bevel gear, how do you call the angle between an element on the pitch cone and an element on the face cone?
a) Face angle b) Pitch angle **c) Addendum angle** d) Dedendum angle

177. It is a Grashof four-bar mechanism in which the shortest link is the frame or fixed link and the other two cranks completely rotate with their axes. How do you call this Grashof four-bar mechanism?
a) Drag-link mechanism b) Crank-rocker mechanism
c) Double-rocker mechanism d) Triple-rocker mechanism

178. "For a planar four-bar linkage, the sum of the shortest and longest lengths cannot be greater than the sum of the remaining two link lengths if there is to be a continuous relative rotation between two members." How do you call the preceding statement?
a) Grubler's Law b) Coriolli's Law **c) Grashof's Law** d) Freudentein's Law

179. Which of the following is not true for an instant center or centro of planar linkages?
a) Centro is a point common to two bodies having the same velocity in each.
b) Centro is a point in one body about which another body does not rotate.
c) Centro is a point in one body about which another body actually turns.
d) Centro is a point in one body about which another body tends to turn.

180. This is the most common work holding device of a shaper machine with the base graduated in degrees that make it possible to swivel any angle. What is this working device?
a) Shaper vise b) Parallel bars and hold down bars c) Lathe holder d) Swivel head

181. This is a shaper operation, which is shaping the given stock and having the excess material remain with a tolerable allowance for finishing. How do you call this operation?
a) Roughing b) Finishing c) Angular cutting d) Contouring

182. How do you call a cutting tool that has two or more cutting edges as in drill presses and milling machine cutters?
a) Grinder b) Single-point cutting tool
c) Multi-point cutting tool d) Two point cutting tool

183. This is the trade name for a patented alloy made up chiefly of cobalt, chromium, and tungsten in varying proportions. What is this trade name?
a) Stellite b) Carboloy c) Stainless steel d) Copper

184. It is called as the transformation of concepts and ideas into useful machinery. What is this?
a) Design b) Synthesis c) Analysis d) Theorem

185. This is a combination of mechanisms and other components that transforms, transmits, or uses energy, load, or motion for a specific purpose. How do you call this?
a) Mechanism b) Engine **c) Machine** d) Linkage

186. It is defined as synergistic collection of machine elements; synergistic because as a design it represents an idea or concept greater than the sum of the individual pats. What is this system?
a) System of mechanisms **b) Mechanical system** c) Design system d) Expert system

187. It may be defined as the displacement per length produced in a solid and as the result of stress. How do you call this?
a) Deformation b) Elongation **c) Strain** d) Stress

188. What is the combination of applied normal and shear stresses that produces maximum principal normal stress or minimum principal normal stress, with a third principal stress between or equivalent to the extremes?
a) Principal shear stress **b) Principal normal stress**
c) Maximum shear stress d) Bending and shear stresses

189. How do you call a load that is applied transversely to longitudinal axis of member?
a) Combined loads b) Concentrated load **c) Bending load** d) Distributed load

190. What is the ability of the material to absorb energy up to fracture?
a) Toughness b) Rigidity c) Resilience d) Stiffness

191. What is the other term for the Maximum-Shear-Stress Theory, as a failure prediction theory?
a) von Mises criterion **b) Tresca yield criterion**
c) Coulomb-Mohr theory d) Modified Mohr theory

192. It is a failure prediction theory, which states that a part subjected to any combination of loads will fail (by yielding or fracturing) whenever the maximum shear stress exceeds a critical value. How do you call this failure prediction theory?
a) Distortion-energy theory **b) Maximum-shear-stress theory**

c) Internal friction theory d) Modified Mohr theory

193. This is a theory in cyclic and impact loading, which states that damage at any stress level, is proportional to number of cycles. What is this theory commonly called?
a) Miner's Rule b) Paris Power Law
c) Goodman Rule d) Manson-Coffin Relationship

194. This is a lubrication where the load-carrying surfaces of the bearing are separated by a relatively thick film of lubricant, so as to prevent metal-to-metal contact; and where the stability of the film can be explained by the laws of fluid mechanics. How do you call this type of lubrication?
a) Hydrostatic lubrication **b) Hydrodynamic lubrication**
c) Elastohydrodynamic lubrication d) Boundary lubrication

195. How do call the speed at which a rotating shaft becomes dynamically unstable?
a) Normal speed b) Variable speed **c) Critical speed** d) Average speed

196. How do you call a ball bearing with race containing pronounced groove for rolling elements?
a) Crown bearing **b) Conrad bearing**
c) Angular-contact bearing d) Cylindrical bearing

197. This is a machining process for producing internal straight cylindrical surface or profiles, with process characteristics and tooling similar to those for turning operations. What is this machining process?
a) Boring b) Drilling c) Reaming d) Milling

198. What is a set of specification for parts, materials, or processes intended to achieve uniformity, efficiency, and a specified quality?
a) Code **b) Standard** c) Law d) Theorem

199. This is a set of specifications for the analysis, design, manufacture, and construction of something; the purpose of which is to achieve a specified degree of safety, efficiency, and performance or quality. How do you call this set of specifications?
a) Code b) Standard c) Law d) Theorem

200. How do call the size to which limits or deviations is assigned and is the same for both members of the fit; it is the exact theoretical size?
a) Nominal size **b) Basic size** c) Maximum size d) Minimum size

201. What is the algebraic difference between a size and the corresponding basic size?
a) Tolerance b) Allowance **c) Deviation** d) Limit

202. What is the difference between the maximum and minimum size limits of a part?
a) Allowance **b) Tolerance** c) Deviation d) Basic size

203. This is used either for very accurate angular measurements or for locating work at a given angle; is used together with precision gage blocks. What is this?
a) Protractor b) Compound rest c) **Sine bar** d) Micrometer