1. The train value of gear train is _____.
   A. equal to the speed ratio
   B. double the speed ratio
   C. half of the speed ratio
   D. reciprocal of the speed ratio

$$TV = \frac{1}{SR}$$

2. A hoist lifts a 3000-kg load a height of 8 m in a time of 20 s. Compute the efficiency of the hoist if the power is supplied to the engine is 18 hp.
   A. 78 %
   B. 88 %
   C. 80 %
   D. 86 %

$$e = \frac{P_o}{P_i} \qquad P_o \rightarrow \frac{Fd}{t} \qquad P_i \rightarrow 18\ hp$$

$$= \frac{\dfrac{(3000 \times 9.81)\,N\ (8\,m)}{20\,s} \times \dfrac{1\,kW}{1000\,W}}{18\ HP \times \dfrac{0.746\ kW}{HP}} \qquad N\text{-}m/s \rightarrow W$$

$$= 88\%$$

3. Neglecting spoke effect, calculate the energy stored in the rim of a flywheel made of cast iron 24 in. in diameter, having a rim 5 inches wide by 4 inches deep when running at 1000 rpm. The internal radius of the rim is 8 inches. Note: density of material is 450 lb/cu.ft.

A. 40,122.28 ft-lb
B. 38,614.21 ft-lb
C. 58,234.36 ft-lb
D. 50,165.32 ft-lb

1200 RPM

$KE = \frac{1}{2} I \omega^2$

$I = \frac{1}{2} m r^2$

$D_o = 24$ in

$D_i = 2 \times 8 = 16$ in

$m = \pi D_m \, b \, t \, \gamma$

$= \pi \left(\frac{D_o + D_i}{2} \right) b \, t \, \gamma$

$= \pi \left(\frac{24 + 16}{2} \right) (5 \times 4) \left(450 \frac{lb}{ft^3} \right) \times \left(\frac{1 ft}{12 in} \right)^3$

$m = 327.25$ lbs

$I = \frac{1}{2} (327.25 \text{ lbs}) \left(\frac{24}{2} \right)^2 in^2 \times \left(\frac{1 ft}{12 in} \right)^2$

$= 163.625 \; lb_m - ft^2$

$\omega = \left(1200 \times \frac{2\pi}{60} \right) = 125.66 \text{ rad/s}$

$I = \frac{1}{2} \left(163.625 \; lb_m - ft^2 \right) \left(125.66 \right)^2 rad/s^2$

$\div \; 32.2 \; lb_m - ft/s^2$

lb_F

$I = 40,122.08 \; ft - lb_F$

4. A wet, steel-backed asbestos clutch with hardened steel plates is being designed to transmit 33 N-m. The coefficient of friction is 0.12. Slip will occur at 300% of the rated torque. The maximum and minimum friction surface diameters are 115 mm and 65 mm respectively. The contact pressure is 700 kPa. How many plates are needed?

A. 4 C. 3
B. 6 D. 5

$r_m = \frac{1}{3}\left[\frac{d_o^3 - d_i^3}{d_o^2 - d_i^2}\right]$

$A = \frac{\pi}{4}(d_o^2 - d_i^2)$

ASSUME UNIFORM PRESSURE

$T = n f F_a r_m$

$F_a = P A$

$(33\ \text{N-m} \times 300\%) = n(0.12)(4948\ \text{N})\left[\frac{1}{3}\left(\frac{0.115^3 - 0.065^3}{0.115^2 - 0.065^2}\right)\right]$

$= \left(700{,}000\ \frac{\text{N}}{\text{m}^2}\right)\frac{\pi}{4}\left(0.115^2 - 0.065^2\right)\text{m}^2$

$= 4948\ \text{N}$

$n = 3.61 \approx \boxed{4}$

5. Calculate the cutting speed in feet per minute if the spindle speed of a 3/4 in drill is 400 rpm.

A. 157 fpm
B. 36 fpm
C. 15.24 fpm
D. 78.5 fpm

$$V = \pi D N = \pi \left(\frac{3/4 \text{ in}}{} \times \frac{1 \text{ ft}}{12 \text{ in}} \right) \left(400 \frac{r}{\text{min}} \right)$$

$$= 78.5 \text{ ft/min}$$

6. A 60-inch diameter steel pipe, 3/8 thick, carries water under a pressure head of 550 ft. Determine the hoop stress in the steel?

A. 19,000 psi
B. 11,200 psi
C. 38,000 psi
D. 12,400 psi

$$\frac{t}{d} = \frac{3/8}{60} = 6.25 \times 10^{-3}$$

$$\frac{t}{d} < 0.10$$

THIN WALLED!!!

$$S = \frac{Pd}{2t} \rightarrow \gamma h$$

$$= \frac{\left(62.4 \frac{lb}{ft^3} \times 550\,ft \times \left(\frac{1\,ft}{12\,in}\right)^2\right)(60\,in)}{2\,(3/8\,in)}$$

$$= 19{,}066.67\ psi$$

B. 11,200 psi

7. A spring has a natural length of 10 inches when at rest. If force 10 lbs is required to stretch it 1 inch, find the work required to stretch the spring from a total length of 13 inches to 15 inches ?

A. 6.667 ft-lbf
B. 23.333 ft-lbf
C. 3.33 ft-lbf
D. 0.6667 ft-lbf

$$W_S = \int_{L_1 - L_{NAT}}^{L_2 - L_{NAT}} \frac{F}{SL} \times dx$$

$$= \int_{13-10}^{15-10} \frac{10}{1} \times dx \quad , \text{lb-in}$$

$$= 80 \text{ lb-in} \times \frac{1 \text{ ft}}{12 \text{ in}} = \boxed{6.667 \text{ ft-lb}}$$

8. It is an age hardenable wrought alloy which has mechanical properties comparable to those of heat treated alloy steel of the same order of hardness and resistance to corrosion similar to that of monel. What is this alloy of nickel?

A. R Monel
B. S Monel
C. KR Monel
D. K Monel

9. A flat belt 4 in and 3/16 in thick operates on pulleys of diameter 5 and 15 inches transmits 10 hp. The friction coefficient between the belt and the pulleys is 0.30. The belts specific weight is 0.04 lb/cu in. The pulleys are rotating at 1500 rpm and they are 5 feet apart. Calculate effective belt pull.

A. 124 lb
B. 178 lb
C. 156 lb
D. 168 lb

$$P = (F_1 - F_2)\, v \longrightarrow \pi D N$$

EFFECTIVE BELT PULL

$$10\ \cancel{HP} \times 550\ \frac{\cancel{Ft\text{-}lb}}{\cancel{s}} \Big/ \cancel{HP} = (F_1 - F_2)\left[\pi\left(\frac{5}{12}\right)\cancel{Ft}\left(\frac{1500}{60}\right)\frac{r}{\cancel{s}}\right]$$

$$F_1 - F_2 = 168\ lbs$$

10. A solid steel machine shaft with a safe shearing stress of 7000 psi transmits a torque of 15,500 in-lb. What is the length of the square key if it 1.5 times the diameter of the shaft?

A. 2.0 in.
B. 2.5 in
C. 1.75 in.
D. 3 in.

$$S = \frac{16T}{\pi d^3}$$

$$7000 \frac{lb}{in^2} = \frac{16(15{,}500\ in\text{-}lb)}{\pi d^3}$$

$$d = 2.24\ in$$

$$L = 1.5\,d = 1.5(2.24) = 3.36\ in$$

11. A helical extension spring is wound from 0.07 in.-diameter wire with a mean diameter of helix of 0.75 inch. Find the approximate value of the load that the spring can sustain before noticeable deflection occur. Note: shearing stress is 21,000 psi.

A. 2.78 lb
B. 4.37 lb
C. 3.57 lb
D. 5.76 lb

$$S = \frac{8KFC}{\pi d_w^2}$$

$$K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

$$C = \frac{D_m}{d_w} = \frac{0.75}{0.07} = 10.7$$

$$21{,}000 \frac{lb}{in^2} = \frac{8(1.135)(F)(10.7)}{\pi (0.07)^2 in^2}$$

$$K = \frac{4(10.7)-1}{4(10.7)-4} + \frac{0.615}{10.7} = 1.135$$

$$F = 3.327$$

12. A flanged coupling is designed to use 6 bolts on a 4-in diameter bolt circle. The allowable stress in shear is 12,000 psi; the maximum torqued is 50 ft-lbf. Find the diameter of the bolt required.

A. 0.032 in
B. 0.064 in
C. 0.073 in.
D. 0.086 in

$$S_S = \frac{2T}{n_B A_B D_{BC}}$$

$$A_B = \frac{\pi}{4} d_B^2$$

$$12{,}000 \frac{lb}{in^2} = \frac{2\left(50\ ft\text{-}lbf \times \frac{12\ in}{1\ ft}\right)}{6\left(\frac{\pi}{4}(d_B)^2\right)(4\ in)}$$

$$\boxed{d_B = 0.073\ in}$$

13. Projection welding belongs to what category of welding process?
   A. Arc welding
   B. Gas welding
   C. Resistance welding
   D. Forge welding

14. A large hangar door is required to be stopped at the end of its travel by a constant force snubber. The door weighs 10,000 lbs and its speed is 1 ft/s when it strikes the snubber. What constant force is required by the snubber to stop the door within a distance of 1 ft.?
   A. 310.56 lbs
   B. 301.65 lbs
   C. 155.28 lbs
   D. 128.55 lbs

$F = ma$

$v_f^2 = v_0^2 - 2as$

$0 = 1^2 - 2a(1\,ft)$

$a = 0.5\ ft/s^2$

$$F = \frac{(10{,}000\ lbm)(0.5\ ft/s^2)}{32.2\ \frac{lbm \cdot ft/s^2}{1\ lbf}} = 155.28\ lbs$$

15. A heavy-duty sleeve bearing is used with good ventilation. The bearing has a diameter of 2 in and a length of 4 in. The load on the bearing is 2200 lb. A shaft rotates 200 rpm in the bearing. Find the heat radiating capacity. The coefficient of friction is 0.02.

A. 0.7404 Btu/min-sq.in
B. 0.8765 Btu/min-sq.in
C. 0.7654 Btu/min-sq.in
D. 0.8043 Btu/min-sq.in

$$HC = \frac{P}{A} \qquad P = \frac{TN}{63025} \qquad T = f\,Fr \qquad A = L \times D$$

$$P = \frac{(0.02)(2200\ \text{lb})\left(\frac{2}{2}\ \text{in}\right)(200\ \text{rpm})}{63025}$$

$$P = 0.1396\ \text{HP} \times \frac{42.4\ \text{BTU/min}}{1\ \text{HP}}$$

$$= 5.92\ \frac{\text{BTU}}{\text{min}}$$

$$A = L \times D = 4\ \text{in} \times 2\ \text{in} = 8\ \text{in}^2$$

$$= \frac{5.92\ \text{BTU/min}}{8\ \text{in}^2}$$

$$= 0.7400\ \frac{\text{BTU}}{\text{min-in}^2}$$

16. If the machining time to drill a hole 20 mm diameter is 19.5 seconds in a workpiece 30 mm thick with a feed of 0.2 mm/rev., what is the cutting speed?
   A. 35 m/min
   B. 50 m/min
   C. 20 m/min
   D. 45 m/min

17. Kevlar epoxy composite is widely used in _____.
   A. interior decoration
   B. navy
   C. aerospace
   D. Automobiles

18. Find the root area of a 1-inch bolt, which has 8V threads per inch.
   A. 0.345 sq. in.
   B. 0.785 sq. in
   C. 0.482 sq.in.
   D. 0.314 sq. in

$$A = \frac{\pi}{4} d^2$$

$$= \frac{\pi}{4} (1\,in)^2 = \boxed{0.785\ in^2}$$

$$V = \pi D N$$

$$N = \frac{d}{ft} = \frac{20\ mm}{0.2\ \frac{mm}{rev} \times 19.5\ sec \times \frac{1\,min}{60\,sec}}$$

$$= 307.7\ \frac{rev}{min}$$

$$V = \pi (0.02\,m)\left(307.7\ \frac{r}{min}\right)$$

$$= 19.33\ \frac{m}{min} \approx \boxed{20\ \frac{m}{min}}$$

19. An interrupted quenching process resulting in an austenite to martensite transition is _____.
   A. Normalizing
   B. Martempering
   C. Austenitizing
   D. Austempering

20. A pair of mating spur gears have 14 1/2 deg. Full depth involute teeth of 2 1/2 diametral pitch. The pitch diameter of the smaller gear is 6.4 inches. If the transmission ratio is 3 to 2. Calculate the dedendum
   A. 0.0628 in.
   B. 0.862 in.
   C. 0.426 in.
   D. 0.4 in.

AUSTENITE TO MARTENSITE = MARTEMPERING

AUSTENITE TO BAINITE = AUSTEMPERING

(20.) $\phi = 14.5°$

$$d = \frac{1.157}{P_d} = \frac{1.157}{2.5}$$

$$= \boxed{0.4628 \text{ in}}$$

21. A mass, m, of 0.020 kg is hanging from a spring whose spring constant, k, is 0.44 N/m. If the mass is pulled down and released, what is the period of oscillation?

A. 1.34 s
B. 0.50 s
C. 1.5 s
D. 2.1 s

$$t = 2\pi\sqrt{\frac{m}{k}}$$

$$= 2\pi\sqrt{\frac{0.020}{0.44}} = 1.34 \text{ s}$$

22. A helical-coil spring has a mean diameter of 1 inch and a wire diameter of 1/8 in. If the shearing stress is 60,000 psi, what how much load can it support?

A. 41.8 lb
B. 24.5 lb
C. 53.4 lb
D. 38.7 lb

$$C = \frac{D_m}{d_w} = \frac{1}{1/8} = 8$$

$$S = \frac{8KFC}{\pi d_w^2}$$

$$K = \frac{4(8)-1}{4(8)-4} + \frac{0.615}{8}$$

$$60{,}000 = \frac{8(1.184)F(8)}{\pi (1/8)^2}$$

$$K = 1.184$$

$$F = 38.7 \text{ lbs}$$

23. A punch press is to have a capacity of 8000 lb through a - inch stroke. For the efficiency and cost a small motor, a flywheel was used. What flywheel effect is required to maintain the flywheel within 20% of its no-load speed of 600 rpm?

A. 1.5 in-lb-sec(squared)
B. 3.4 in-lb-sec(squared)
C. 2.8 in-lb-sec(squared)
D. 3.2 in-lb-sec(squared)

ASSUME 7 in stroke

$$= (8000\ \text{lb})(7\ \text{in})\left(\frac{1}{600\ \frac{\text{rev}}{\text{min}} \times \frac{2\pi\ \text{rad}}{\text{rev}} \times \frac{1\ \text{min}}{60\ \text{s}}}\right)^2 \frac{\text{sec}^2}{\text{rad}} \times 20\%$$

$$= 2.8\ \text{in-lb-sec}^2$$

24. When crank rotates with uniform speed, it has _____acceleration only.

A. tangential
B. radial
C. coriolis
D. gyroscopic

25. Two extension springs are hooked in parallel and support a load of 100 lb. One spring has a constant of 50 lb/in and the other a constant of 100 lb/in. What is the deflection of the load?

A. 16.94 mm
B. 76.3 mm
C. 0.667 mm.
D. 66.7 mm

$$\delta = \frac{F_T}{k_T}$$

$$k_T = k_1 + k_2$$

$$= 50 + 100$$

$$= 150 \frac{lb}{in}$$

$$= \frac{100\ lb}{150 \frac{lb}{in} \times \frac{1\ in}{25.4\ mm}}$$

$$= 16.94\ mm$$

26. An inclined plane 5 m long has its upper end 1 meter above the ground. A load of 100 N is pushed up the plane against a force of friction of 5 N. What the is actual mechanical advantage?

A. 1.25
B. 4
C. 5
D. 0.8

$$AMA = \frac{5\text{m}}{1\text{m}} = \boxed{5}$$

27. Springs A and B have spring constants of 2 kN/m and 1 kN/m respectively. Spring A is hung from a rigid horizontal beam and its other end is attached to an end of spring B. The pair of springs is then used to suspend a body mass of 50 kg from the lower end of spring B. What is the period of harmonic oscillation of the system?

A. 1.09
B. 1.72
C. 1.45
D. 2.01

28. Hand shears can be used for cutting sheets up to _____.

A. 0.2 mm
B. 0.8 mm
C. 0.4 mm
D. 1.6 mm

Continued on Page 4

$$t = 2\pi \sqrt{\frac{m}{k_T}}$$

$$= 2\pi \sqrt{\frac{50\ kg}{666.667\ N/m}}$$

$$t = 1.72\ sec$$ //

SPRING IN SERIES

$$\frac{1}{k_T} = \frac{1}{k_1} + \frac{1}{k_2}$$

$$\frac{1}{k_T} = \frac{1}{2} + \frac{1}{1}$$

$$k_T = \frac{2}{3}\ kN/m \times \frac{1000N}{1\ kN}$$

$$= 666.667\ N/m$$

29. A disk brake has two pads of included angle of 45 deg each. Outside radius 6 in. Inside radius 4 in. Coefficient of friction 0.4. Maximum lining pressure 100 psi. Find the torque capacity for both shoes.

A. 1256.6 in-lb
B. 2513.2 in-lb
C. 2143.5 in-lb
D. 628.3 in- lb

0.2

ASSUME UNIFORM WEAR

$$r_m = \frac{r_o + r_i}{2} = \frac{6+4}{2} = 5 \text{ in}$$

$$A = \pi d_i t$$
$$= \pi (4 \times 2)(2) \text{ in}^2$$
$$= 16\pi \text{ in}^2$$

$r_o = r_i + t$

$t = r_o - r_i$
$= 6 - 4 = 2$

$$F_a = PA$$
$$= 100 \frac{\text{lb}}{\text{in}^2} \times 16\pi \text{ in}^2$$
$$= 5026.548 \text{ lbs}$$

$$T = \eta f F_a r_m$$

$$T = (0.2)(5026.548 \text{ lbs})(5 \text{ in})$$

$$T = \frac{5026.548}{2}$$ → BOTH SHOES

$$T = 2513.2 \text{ in-lb}$$

30. Two sheets of aluminum on an aircraft wing are to be held together by aluminum rivets of cross-sectional area of 0.25 sq. in. The shearing stress on each rivet must not exceed one-tenth of the elastic limit for aluminum. How many rivets are needed if each rivet supports the same fraction of a total shearing force of 25,000 kN? Assume that the elastic limit stress is 131 Mpa.

A. 10 rivets
B. 20 rivets
C. 35 rivets
D. 53 rivets

55 sq.in

13.1 MPa

$$\text{no. of rivets} = \frac{F_T}{F_{RIVET}} = \frac{25{,}000{,}000\ \text{N}}{13.1\ \frac{\text{N}}{\text{mm}^2} \times 55\ \text{in}^2 \times \left(\frac{25.4\ \text{mm}}{1\ \text{in}}\right)^2}$$

F_{RIVET} → SA

$$= 53.78$$

$$= 53 \text{ rivets}$$

31. A copper column of annular cross section has an outer diameter of 5 m, and is subjected to an axial loading of 200 kN. The allowable compressive stress is 14.4 kPa. Compute the wall thickness.

A. 1.15 m
B. 2 m
C. 0.8 m
D. 1 m

32. The moment diagram for a cantilever beam subjected to bending moment at the end of beam will be _____.

A. rectangle
B. triangle
C. elliptical
D. cubic parabola

$$S = \frac{F}{A} \rightarrow \frac{\pi}{4}(D_o^2 - D_i^2)$$

$$D_o = 5\ m$$

$$D_o = D_i + 2t$$

$$D_i = D_o - 2t$$

$$14.4\ \frac{kN}{m^2} = \frac{200\ kN}{\frac{\pi}{4}\left(5^2 - (5-2t)^2\right)}$$

$$\boxed{t = 1.15\ m}$$

33. A bridge's steel midspan is to be installed at 35 deg.F during winter. Rivets holes at each end of the midspan must measure 54.7 ft from the center. The I-beams for the midspan are prepared in a fabrication shop with a controlled temperature of 72 deg F. Compute the change to the center distance that should be made when the rivet holes are drilled in the shop.

A. 4.0 mm
B. 0.12 mm
C. - 0.12 mm
D. - 4.0 mm

$$\delta_{TH} = \alpha L \Delta T$$

$$= \left(6.5\times10^{-6}\ /{}^{\circ}\!F\right)\left(54.7\ ft \times \frac{12\ in}{ft} \times \frac{25.4\ mm}{1\ in}\right)(72-35)\ {}^{\circ}\!F$$

$$= 4\ mm$$

34. How many revolutions are needed to lift table of height 300 mm if a machine table is lifted by means of a two start screw thread which has a pitch of 6 mm?

A. 20
B. 50
C. 30
D. 40

HEIGHT

$$IMA = \frac{2\pi L}{P} = \frac{2\pi (300\ \text{mm})}{6\ \text{mm}}$$

$$= 100\pi\ \text{rad} \times \frac{1\ \text{rev}}{2\pi\ \text{rad}}$$

$$= 50\ \text{rev}$$

35. A 2000-kg elevator rises from rest in the basement to the fourth floor, a distance of 25 m. As it passes the fourth floor, its speed is 3 m/s. There is a constant frictional force of 500 N. Calculate the work exerted against friction.

A. 11.5 ft-lb
B. 12.5 ft-lb
C. 9,218 ft-lb
D. 12,405 ft-lb

$$W_{FRICTION} = F_{FRICTION} \times d$$

$$= (500\ N \times 25\ m) \times \frac{1\ ft\text{-}lb}{1.356\ J}$$

$$= 9,218.29\ ft\text{-}lb$$

36. Find the diametral pitch of a gear whose circular pitch is 1.5 inch.
A. 1.0472 in
B. 4.71 in
C. 2.094 in
D. 1 in

37. A pair of mating spur gears have 14 1/2 deg. Full depth involute teeth of 2 1/2 diametral pitch. The pitch diameter of the smaller gear is 6.4 inches. If the transmission ratio is 3 to 2. Calculate the outside diameter of the pinion.
A. 7.2 in
B. 6.5 in.
C. 5.4 in.
D. 3.2 in.

Continued on Page 5

$$P_D = \frac{\pi}{P_C} = \frac{\pi}{1.5}$$

$$= 2.094 \text{ in}$$

$$D_o = D + 2a$$

$$a = \frac{1}{P_d} = \frac{1}{2.5}$$

$$D_o = 6.4 \text{ in} + 2\left(\frac{1}{2.5}\right) \text{ in}$$

$$= \boxed{7.2 \text{ in}}$$

38. A solid machine shaft with a safe shearing stress of 7000 psi transmits a torque of 10,500 in-lb. A square key is used whose width is equal to the shaft diameter and whose length is 1.5times the shaft diameter. What is the length of the key?

A. 7.5 cm
B. 2.9 cm
C. 4.9 cm
D. 1.9 cm

$$S = \frac{16T}{\pi d^3} \qquad 7000 = \frac{16(10,500)}{\pi d^3}$$

$$d = 1.97 \text{ in}$$

$$L = 1.5d = 1.5\left(1.97 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}}\right)$$

$$= 7.5 \text{ cm}$$

39. A triple threaded worm has a pitch diameter of 4 inches and an axial pitch of 0.75 in. Determine the lead angle

A. 11.45 deg
B. 10.15 deg
C. 14.50 deg
D. 12.54 deg

$$\tan\lambda = \frac{L}{\pi D_w} \quad \rightarrow np$$

$$\tan\lambda = \frac{3\,(0.75)}{\pi\,(4)}$$

$$\lambda = 10.15^\circ$$

40. What is the diameter of the rivet if the length of the snap head rivet is 100 mm and the thickness is 50 mm?

A. 53.64 mm
B. 40.26 mm
C. 52.76 mm
D. 41.67 mm

EMPIRICAL :

$$D_R = L - 0.93t$$
$$= 100 - 0.93(50)$$
$$= 53.5\,mm$$

41. A coil spring 2-in. in outside diameter made of 0.25-in. wire is to support a mass of 100 lb, find the number of coils if it deflects 1.5 in. under the given load condition. Modulus of rigidity for steel is 11.5 x 10(raised to 6) psi.

A. 18
B. 25
C. 16
D. 21

$$C = \frac{D_m}{d_w} \rightarrow D_o - d_w$$

$$= \frac{2 - 0.25}{0.25}$$

$$= 7$$

$$\delta = \frac{8FC^3 n_c}{Gd_w}$$

$$1.5 = \frac{8(100)(7)^3(n_c)}{(11.5\times10^6)(0.25)}$$

$$n = 15.7 \approx \boxed{16}$$

42. A spring has a natural length of 12 inches when at rest. If force 10 lbs is required to stretch it 1 inch, find the work required to stretch the spring from a total length of 13 inches to 15 inches ?

A. 6.667 ft-lbf
B. 0.6667 ft-lbf
C. 3.33 ft-lbf
D. 23.333 ft-lbf

$$W_S = \int_{L_1 - L_{NAT}}^{L_2 - L_{NAT}} \frac{F}{\delta L} \times dx$$

$$= \int_{13-12}^{15-12} \frac{10}{1} \times dx \quad , \quad in - lb_F$$

$$= 40\ \cancel{in}\text{-}lb_F \times \frac{1 ft}{12\ \cancel{in}} = 3.33\ ft\text{-}lb_F$$

43. Compute the shear strain if the shear stress of a material is given to be 5803 psi and its shear modulus of elasticity is 65 Gpa.

A. 2.4 x 10 (raised to - 4) rad
B. 2.14 x 10 (raised to -3) rad
C. 6.15 x 10 (raised to - 4) rad
D. 4.7 x 10 (raised to - 4) rad

$$\tau = G\,\varepsilon_s$$

$$5803\ \frac{lb}{in^2} = \left((65\times10^{3})\ MPa \times \frac{14.7\ psi}{0.101325\ MPa}\right)(\varepsilon_s)$$

$$\varepsilon_s = 6.15\times10^{-4}\ rad$$

44. Which of the following statement is INCORRECT?
   A. Geneva mechanism is an intermittent motion device
   B. Inversions of a mechanism are created by fixing different links one at a time
   C. Grubler's criterion assumes mobility of a planar mechanism to be one.
   D. Grashofs rule states that for a planar crank-rocker four bar mechanism, the sum of the shortest and longest link lengths cannot be less than the sum of the remaining two link lengths

45. What is the diameter of the cylinder of a hydraulic press with pressure of 1000 psi and cylinder wall thickness of 4 in? Allow a tensile stress of 2500 psi.
   A. 14.29 in.
   B. 15 in.
   C. 20 in.
   D. 20.46 in.

$$\frac{t}{d} = \frac{4}{14.29} = 0.28$$

$$\frac{t}{d} > 0.10 \; ; \text{ THICK WALLED}$$

$$t = \frac{D}{2}\left[\sqrt{\frac{S_t + P_i}{S_t - P_i}} - 1\right]$$

$$4 = \frac{D}{2}\left[\sqrt{\frac{2500 + 1000}{2500 - 1000}} - 1\right] \qquad D = 15.165 \text{ in}$$

B. 15 in.

46. A shaft B, turning 140 rpm, has pulley 4, 30 inches in diameter keyed to it. Pulley 4 is belted to a pulley 2, 20 inches in diameter keyed on a shaft A. Find the speed of pulley 2.
   A. 120 rpm
   B. 360 rpm
   C. 420 rpm
   D. 210 rpm

Continued on Page 6

$$N_1 D_1 = N_2 D_2$$

$$(140)(30) = N_2(20)$$

$$N_2 = 210 \text{ rpm}$$

47. A gear set having a gear ratio of 3 is to be used at a center distance of 16 inches. If the gear has 80 teeth, what must be the circular pitch?

A. 26.6 mm
B. 24.6 mm
C. 25.6 mm
D. 23.6 mm

48. What power is required to lift a load of 22.24 kN by means of a cable wrapped around the drum of a hoist, the drum being 20 in. in diameter and is making 24 rpm?

A. 14.2 kW
B. 10.7 Hp
C. 19 kW
D. 38 Hp

$$C = \frac{T_1 + T_2}{2P_D} \longrightarrow \frac{\pi}{P_C}$$

$$16 = \frac{80 + \frac{80}{3}}{2\left(\frac{\pi}{P_C}\right)}$$

$$P_C = 0.94 \text{ in} \times \frac{25.4 \text{ mm}}{1 \text{ in}}$$

$$= 23.9 \text{ mm}$$

$$P = \frac{TN}{9.549 \times 10^6} \longrightarrow F_r$$

$$P = \frac{22{,}240 \text{ N} \times \left(\frac{20}{2} \text{ in} \times \frac{25.4 \text{ mm}}{1 \text{ in}}\right)(24 \text{ rpm})}{9.549 \times 10^6}$$

$$P = 14.2 \text{ kW}$$

49. A mechanism starts from rest and accelerates at 50 rad/sec (squared). After 10 seconds, a bolt flies off. The bolt circle has a diameter of 12 inches. Calculate the speed of the bolt when it leaves the mechanism.

A. 85 mph
B. 1100 mph
C. 54 mph
D. 170 mph

$$v_f = v_0^{\,0} + a\,t$$

$$a = r\alpha = \left(\frac{12}{2}\,\text{in} \times \frac{1\,\text{ft}}{12\,\text{in}}\right)\left(50\,\frac{\text{rad}}{s^2}\right)$$

$$a = 25\,\text{ft}/s^2$$

$$v_f = 0 + \left(25\,\text{ft}/s^2\right)(10\,s)$$

$$= 250\,\text{ft}/s \times \frac{1\,\text{mi}}{5280\,\text{ft}} \times \frac{3600\,s}{\text{hr}} = \boxed{170.45\,\text{mph}}$$

B. 1100 mph D. 170 mph

50. A 6-in long 1/2 in diameter 304 stainless steel rod is being reduced in diameter to 0.480 in by turning on a lathe. The spindle rotates at N = 400 rpm, and the tool is traveling at an axial speed of 8 in/min. Calculate the feed in inch per rev.

A. 0.005 in/rev
B. 0.02 in/rev
C. 0.03 in/rev
D. 0.01 in/rev

$$\text{FEED} = \frac{V}{N} = \frac{8 \text{ in/min}}{400 \text{ rev/min}} = 0.02 \text{ in/rev}$$

51. The energy of recoil of a rocket launcher of mass 4536 kg is absorbed in a recoil spring. At the end of the recoil, a damping dashpot engages so that the launcher returns to the firing position without any oscillation (critical damping). The launcher recoils 3 m with an initial speed of 12 m/s. Compute the recoil spring constant.

A. 40.5 kN/m
B. 25.3 kN/m
C. 30.5 kN/m
D. 72.5 kN/m

$k = ?$

$$W\delta = \frac{1}{2}k\delta^2$$

$$(4536 \times 9.81)\,N \times 3\,m = \frac{1}{2}k \times (3)^2\,m^2$$

$$k = 29{,}665.44\ N/m$$

$$= 29.665\ kN/m \approx \boxed{30.5\ kN/m}$$

52. A helical coil spring has a mean coil diameter of 1 in. and a wire diameter of 1/10 inch. Determine the curve correction factor of the spring.

A. 1.1414
B. 1.1144
C. 1.0903
D. 1.3090

$$K_{CORRECTION} = \frac{K_W}{K_S} = \frac{\frac{4C-1}{4C-4} + \frac{0.615}{C}}{1 + \frac{1}{2C}}$$

$$C = \frac{D_m}{d_W} = \frac{1}{1/10}$$

$$C = 10$$

$$= 1.0903$$

53. An 18-tooth straight spur gear transmits a torque of 1200 N-mm. The pitch circle diameter is 19 mm, and the pressure angle is 14.5½. What is the radial force on the gear?

A. 126.32 N
B. 66.7 N
C. 133.3 N
D. 63.15 N

$$T = Fr$$

$$1200\ \text{N-mm} = F\left(\frac{19}{2}\right)\text{mm}$$

$$F = 126.32\ \text{N}$$

54. When a coil spring with a spring scale of 100 lb/in is compressed 1 1/4 inches, the coils are closed. The allowable shearing stress if 50,000 psi and the spring index is 8, the ends are squared and ground, and G = 12 x 10 (raised to 6) psi. Calculate the coil diameter.

A. 1.96 in.
C. 0.872 in.
B. 1.54 in.
D. 0.246 in.

$C = 8$

$$S = \frac{8KFC}{\pi d_w^2} \qquad K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

$$K = 1.184$$

$$50{,}000 \frac{lb}{in^2} = \frac{8(1.184)(125\,lb)(8)}{\pi d_w^2}$$

$$k = \frac{F}{\delta}$$

$$d_w = 0.246\,in$$

$$100 \frac{lb}{in} = \frac{F}{1\frac{1}{4}\,in}$$

$$F = 125\,lbs$$

55. A pair of mating spur gears have 14½ deg. Full depth involute teeth of 2½ diametral pitch. The pitch diameter of the smaller gear is 6.4 inches. If the transmission ratio is 3 to 2. Calculate the root diameter of the pinion.

A. 5.476 in.
B. 3.132 in.
C. 4.456 in.
D. 4.146 in.

Continued on Page 7

TQDS Ver 2.1.9

$\phi = 14.5°$

$d = \frac{1.157}{P_d}$

$$D_r = D - 2d$$

$$= 6.4 - 2\left(\frac{1.157}{2.5}\right)$$

$$= 5.474 \text{ in} //$$

56. If a 65-cm diameter, steel flywheel of constant thickness is used, how thick should it be? The specific gravity of steel is 7.85. The inertia of flywheel is 18.31 kg-m(squared).

A. 11.24 cm
B. 24.52 cm
C. 12.54 cm
D. 13.33 cm

57. In double helical gears the helix angle may be made up to _____.

A. 75 deg
B. 60 deg
C. 30 deg
D. 45 deg

$$I = \frac{1}{2} m r^2$$

$$18.31\ kg\text{-}m^2 = \frac{1}{2} m \left(\frac{0.65}{2}\right)^2 m^2$$

$$m = 346.7\ kg$$

$$m = \rho V \rightarrow At \rightarrow \frac{\pi}{4} d^2$$

$$346.7\ kg = \left(7850\ \frac{kg}{m^3}\right)\left(\frac{\pi}{4}(0.65)^2\right) m^2 (t)$$

$$t = 0.1331\ m$$

$$t = 18.31\ cm$$

58. A cutter is a 3-inch diameter high-speed steel plain or slab milling cutter with 8 teeth. The width of the cut is 2 inches, the depth of the cut is 0.062 inch, and the cutting speed as given in the table is 85 fpm and the selected feed rate is 0.008 inch per tooth. What is the approximate feed rate of milling a piece of AISI 1040 steel having a hardness of 180 BHN?

A. 5 inch/min
B. 7 inch/min
C. 10 inch/min
D. 9 inch/min

59. Sevolute functions are used in calculating the form diameter of involute splines. What is the sevolute of 20 degrees?

A. 2.77
B. 1.049274
C. 0.636
D. 0.0149

$$V_{FEED} = f N T$$

$$V_{CUTTING} = \pi D N$$

$$\left(85 \frac{ft}{min} \times \frac{12\ in}{1\ ft}\right) = \pi (3\ in) N$$

$$N = 108.225\ rev/min$$

$$V_{FEED} = \left(0.008 \frac{in}{tooth}\right)\left(108.225 \frac{rev}{min}\right)\left(8 \frac{tooth}{rev}\right)$$

$$= 7\ in/min$$

$$SEV(\theta) = \frac{1}{\cos\theta} - INV\theta$$

$$INV\theta = \tan\theta - \left(\theta \times \frac{\pi}{180}\right)$$

$$SEV\theta = \frac{1}{\cos 20} - \left[\tan 20 - \left(20 \times \frac{\pi}{180}\right)\right]$$

$$= 1.049274$$

60. A pulley 2, 24 inches in diameter and keyed to a shaft A turning 360 rpm, has belt connected to a pulley 4, 36 inches in diameter, on another shaft B. Find the speed of the pulley 4.

A. 240 rpm
B. 180 rpm
C. 360 rpm
D. 120 rpm

$$N_1 D_1 = N_2 D_2$$

$$(360)(24) = N_2(36)$$

$$N_2 = 240 \text{ rpm}$$

B. 180 lpm

61. A 1/8-in fillet weld 1 inch long carries a steady load P lying along the weld. If the working stress in shear is taken as 11,300 psi. Calculate the load it can carry.
   A. 1345 lbf
   B. 896 lbf
   C. 1000 lbf
   D. 1400 lbf

$$S_s = \frac{P \text{ (LOAD)}}{\frac{\sqrt{2}}{2} t L}$$

$$11{,}300 \frac{lb}{in^2} = \frac{P}{\frac{\sqrt{2}}{2}\left(\frac{1}{8} in\right)(1 in)}$$

$$P = 998.8 \approx \boxed{1000 \text{ lbf}}$$

62. A double thread worm has a pitch diameter of 3 inches. The wheel has 22 teeth and a pitch diameter of 5. Find the gear helix angle?

A. 9.46 deg
B. 4.69 deg
C. 8.61 deg
D. 6.18 deg

GEAR HELIX ANGLE, ψ_G = LEAD ANGLE OF WORM, λ_w

$$\tan \lambda_w = \frac{L}{\pi d_w} \quad (L \to np)$$

$$P = \frac{\pi D_G}{T_G} = \frac{\pi (5)}{22}$$

$$= 0.714$$

$$\tan \lambda_w = \frac{(2)(0.714)}{\pi (5)}$$

$$\boxed{\lambda_w = 8.61^\circ = \psi_G}$$

63. A solid transmission shaft is 3.5 inches in diameter. It is desired to replace it with a hollow shaft of the same material and the same torsional strength, but its weight should only be half as much of the solid shaft. Find the difference of the outside and inside diameter of the hollow shaft in mm.

A. 20.34 mm
B. 10.99 min
C. 16.15 min
D. 34.02 mm

$$D_o = \frac{1+\sqrt{2}}{2} D_s$$

$$= \frac{1+\sqrt{2}}{2}(3.5)$$

$$D_o = 4.225 \text{ in}$$

$$D_o^4 - D_i^4 = D_s^3 D_o$$

$$4.225^4 - D_i^4 = 3.5^3 (4.225)$$

$$D_i = 3.424 \text{ in}$$

$$D_o - D_i = 4.225 - 3.424$$

$$= 0.8 \text{ in} \times \frac{25.4 \text{ mm}}{1 \text{ in}}$$

$$= 20.34 \text{ mm}$$

64. What is the length of a piece of stock with taper per inch of 3/16 if it has a diameter of 3 inches at one end and 1.5 inches at the other end?

A. 4 in
B. 10 in
C. 8 in
D. 6 in

$$TPI = \frac{D - d}{L_{INCHES}}$$

$$\frac{3}{16} = \frac{3 - 1.5}{L_{INCHES}}$$

$$\boxed{L = 8 \text{ in}}$$

B. 10 in

65. A steel pipe is to be used to support a weight of 130 kN. The pipe has the following specifications OD = 100 mm , ID = 90 mm , A = 1500 sq mm, I = 1.7 x10 (raised to 6) (mm to the 4th). Take E = 210 Gpa and yield stress = 250 Mpa. Find the critical load. Note: this is a cantilever column with k = 2.

A. 2.60 m
B. 1.45 m
C. 0.45 m
D. 3.20 m

LENGTH

$$F_c = \frac{\pi^2 E I}{Le^2} \quad Le \rightarrow L \times K$$

$$130{,}000\,N = \frac{\pi^2 \left(210 \times 10^3 \frac{N}{mm^2}\right)\left(1.7 \times 10^6\ mm^4\right)}{(L \times 2)^2}$$

$$L = 2603.05\ mm$$

$$= 2.6\ m$$

66. A 150 hp motor turns a shaft at 2400 rpm. The shaft steps down in diameter from 3.0 to 2.5 inches. Calculate the maximum torsional shear stress if the stress concentration factor is given to be 1.3.

A. 1800 psi
B. 1670 psi
C. 1720 psi
D. 1140 psi

TO GET MAXIMUM SHEAR STRESS, USE SMALLER DIAMETER, $d = 2.5$ in

$$S_{MAX} = \frac{16T}{\pi d^3} \times 1.3$$

$$= \frac{16(3939.0625)}{\pi(2.5)^3} \times 1.3$$

$$= 1670 \text{ psi}$$

$$P = \frac{TN}{63025}$$

$$150 = \frac{T(2400)}{63025}$$

$$T = 3939.0625 \text{ in-lb}$$

D. 1140 psi

67. A multiple-disc clutch consists of 10 steel discs and 9 bronze discs. The effective outside and inside diameters are 8 inches and 6 inches respectively. If an axial force 120 lb is applied and the shaft turns at 1000 rpm, find the horsepower capacity. Assume the coefficient of friction of 0.35 and uniform wear.
   A. 42 hp
   B. 25 hp
   C. 55 hp
   D. 20 hp

68. The motion of a shaft in a circular hole is an example of _____ motion.
   A. successful constraint
   B. completely constraint
   C. free
   D. incompletely constraint

69. Which type of key is used for mounting shifting gears in gear boxes?
   A. Splines
   B. Saddle
   C. Square
   D. Flat

UNIFORM WEAR:

$$r_m = \frac{d_o + d_i}{4}$$

$$T = n f F_a r_m$$

$$T = (10+9-1)(0.35)(120 \text{ lbs})\left(\frac{8+6}{4} \text{ in}\right)$$

$$= 2646 \text{ lb-in}$$

$$P = \frac{TN}{63025} = \frac{(2646)(1000)}{63025}$$

$$= 42 \text{ HP}$$

70. A 60-kg motor sits on four cylindrical rubber blocks. Each cylinder has a height of 3 cm and a cross-sectional area of 15 sq cm. The shear modulus for this rubber is 2 Mpa. If a sideway force of 300 N is applied to the motor, how far will it move sideways?

A. 0.025 cm
B. 0.25 cm
C. 0.075 cm
D. 0.3 cm

$$F = \frac{300\,N}{4}$$

$$\delta = \frac{FL}{AE} = \frac{\left(\frac{300}{4}\,N\right)\left(\frac{3}{100}\,m\right)}{\left[15\,cm^2 \times \left(\frac{1\,m}{100\,cm}\right)^2\right]\left(2\times10^6\right)\frac{N}{m^2}} \times \frac{100\,cm}{1\,m}$$

$$= 0.075\,cm$$

71. A 15 hp motor, whose speed is 1200 rpm is belt connected to the drive shaft of a machine. The pulley A, on the armature shaft of a motor is 12 inches in diameter while that of drive shaft, B, is 30 inches in diameter. What is the torque in the armature shaft?

A. 234 in-lb
B. 788 in-lb
C. 750 in-lb
D. 135 in-lb

$$P = \frac{TN}{63025}$$

$$15 = \frac{T(1200)}{63025}$$

$$T = 788 \text{ in-lb}$$

72. The angle between the line of stroke (line of motion of the follower) and the normal to the pitch curve at any point is referred to as _____ angle.

A. prime
B. cam
C. pressure
D. profile

...spherical vessel has a wall thickness of 3

B. cam D. profile

73. A 2-ft inside diameter spherical vessel has a wall thickness of 3 inches. Compute for the tensile at its inner surface as caused by an internal pressure of 1500 psi and an external pressure of 300 psi.
A. 3123.87 psi C. 1833.33 psi
B. 4113.38 psi D. 1244.25 psi

$d_i = 2\ ft = 24\ in$

$r_i = \frac{24}{2} = 12\ in$

$r_o = r_i + t = 12 + 3 = 15\ in$

$$S_{ti} = \frac{P_i(r_o^2 + r_i^2) - 2P_o r_o^2}{r_o^2 - r_i^2} = \frac{1500(15^2 + 12^2) - 2(300)(15)^2}{15^2 - 12^2} = 5166.67\ psi$$

USE FORMULA OF AXIAL STRESS INSTEAD,

$$S_A = \frac{P_i r_i^2 - P_o r_o^2}{r_o^2 - r_i^2} = \frac{1500(15)^2 - 300(12)^2}{15^2 - 12^2}$$

$$= \boxed{1833.33\ psi}$$

B. 4113.38 psi

74. Determine the maximum permissible velocity V in a cast iron thin rim of a flywheel if the maximum allowable tensile stress in cast iron is 4000 psi. The cast iron weighs 0.255 lb/cu in.
   A. 24.60 in./s
   B. 1250 in./s
   C. 2460 in/s
   D. 62.5 in/s

DEYN'S FORMULA

$$V = \sqrt{k S_T}$$

$k = 10.5$ FOR CAST IRON

$k = 9.5$ FOR STEEL

$$= \sqrt{10.5(4000)}$$

$$= 205 \text{ ft/s} \times \frac{12 \text{ in}}{1 \text{ ft}} = 2460 \text{ in/s}$$

75. The mass of pole piece on an alternator is 10 kg and its center of gravity is at 300 mm from the shaft center . It is secured by 4 bolts and alternator runs at 1000 rpm. What is the diameter of the bolts if the stress in them is not to exceed 40 MPa?

A. 12.16 mm
B. 14.24 mm
C. 16.12 mm
D. 12.44 mm

Continued on Page 9

ASSUME:

NO. OF POLE PIECE = 20

$$S = \frac{F_{BOLT}}{n_B A_B} = \frac{(10 \times 9.81\ \cancel{N}) \times 20}{4\left(\frac{\pi}{4} d^2\right)} = 40\ \frac{\cancel{N}}{mm^2}$$

$$d = 12.49\ mm$$

76. A V-belt is 225 cm long and operates on sheaves of pitch diameters of 32 cm and 40 cm. Compute the center distance.

A. 43 in.
B. 30 in.
C. 56 in.
D. 22 in.

$$L = \pi\left(\frac{d_1 + d_2}{2}\right) + 2C + \frac{(d_2 - d_1)^2}{4C}$$

$$225 = \pi\left(\frac{32 + 40}{2}\right) + 2C + \frac{(40 - 32)^2}{4C}$$

$$C = 55.8\ \text{cm} \times \frac{1\ \text{in}}{2.54\ \text{cm}}$$

$$= 21.97\ \text{in}$$

B. 30 in. D. 22 in.

77. A fixture experiences a static stress of 3500 psi and dynamic stress of 4000 psi. The yield strength is 43,000 psi, and the endurance strength is 8,820 psi. The fatigue stress concentration factor is 1.2. What is the approximate alternating stress?

A. 21.5 ksi
B. 20 ksi
C. 2 Mpa
D. 13.8 Mpa

$$S_A = \frac{1}{2}(S_{max} - S_{min}) \times 1.2$$

$$= \frac{1}{2}(4000 - 3500)\,psi \times 1.2$$

$$= 300\,psi \times \frac{0.101325\,MPa}{14.7\,psi}$$

$$= 2\,MPa$$

B. 20 ksi D. 13.8 MPa

78. A simple disc clutch has elements with outside and inside radii of 250 mm and 100 mm respectively. The axial force is 1200 N. If the coefficient of friction is 0.5, find the torque capacity based on uniform wear.

A. 105 N-m
B. 115 N-m
C. 102 N-m
D. 150 N-m

... aluminum bar of length 2.5 ft

$$T = n f F_a r_m \longrightarrow \frac{r_o + r_i}{2}$$

$$= (1)(0.5)(1200\,N)\left(\frac{0.25 + 0.1}{2}\,m\right)$$

$$= 105\ N\text{-}m$$

B. 115 N-m D. 150 N-m

79. What is most nearly the elongation of the aluminum bar of length 2.5 ft (cross section of 3 cm x 3 cm) when loaded to its yield point ? E = 69 Gpa, and Syield = 255 Mpa. Neglect the weight of the bar.
A. 12 mm C. 2.8 mm
B. 15 mm D. 150 N-m

$$\delta = \frac{FL}{AE} = \frac{SL}{E} = \left(255 \frac{N}{mm^2}\right) \frac{\left(2.5 \text{ ft} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{25.4 \text{ mm}}{1 \text{ in}}\right)}{(69 \times 10^3) \frac{N}{mm^2}}$$

$$\delta = 2.8 \text{ mm}$$

80. A 350 m cable is suspended vertically. At any point along the cable, the strain is proportional to the length of the cable below that point. If strain at the top of the cable is 0.0015, determine the total elongation of the cable.

A. 0.2625 m
B. 0.050 m
C. 0.10 m
D. 0.1532 m

$$\varepsilon = \frac{\delta}{L}$$

$$\delta = \varepsilon L = (0.0015)(350\,m) = 0.525\,m$$

$$\frac{0.525}{2} = \boxed{0.2625\,m}$$

81. Which of the following Thermit welding procedures, produced high temperature?
   A. The combustion of oxygen and acetylene
   B. An exothermal chemical reaction
   C. An electric arc
   D. An electrical reaction

82. Compute the length of a nut such that the shearing failure of the threads shall equal to the tensile failure load of the bolt when the shearing strength is 72% of the tensile strength. Assume pitch diameter of the threads to be the same as the bolt diameter.
   A. 0.4d
   B. 0.2d
   C. 0.9d
   D. 0.7d

$L = (72\%) D_B$

$= 0.72 d_B$

7600

83. A 2 ft diameter solid disc flywheel weighs 200 lbs and is designed to handle 1600 ft-lb kinetic energy change. Its upper speed is 40 fps. Find the coefficient of regulation.
   A. 0.491
   B. 0.194
   C. 0.419
   D. 0.149

84. Two shafts are connected by spur gears. The pitch radii of gears A and B are 4 inches and 20 inches respectively. If shaft A makes 800 rpm and is subject to twisting moment of 1000 inch-pound. What is the tooth pressure of gear B?
   A. 250 lb
   B. 150 lb
   C. 320 lb
   D. 100 lb

Continued on Page 10

(84.)

$F_A = F_B$

$T_A = F_g (r_g)$

$(1000 \text{ in-lb}) = F_g (4 \text{ in})$

$F_g = 250 \text{ lb}$

(83.)

$C_f = \dfrac{2(V_1 - V_2)}{V_1 + V_2}$

$V_1 = 40 \text{ ft/s}$

$KE = \dfrac{1}{2} m_T (V_1^2 - V_2^2)$

$(7600 \text{ ft-lb}) = \dfrac{1}{2} (200 \text{ lb}) (40^2 - V_2^2)$

$V_2 = 26.23 \text{ ft/s}$

$C_f = \dfrac{2(40 - 26.23)}{40 + 26.23}$

$= 0.416$

85. A 1 3/4 in. diameter shaft is supported by two sleeve bearings. The total load on the two bearings is 2800 lb. What is the frictional force per bearing if the coefficient of friction between shaft and bearing is 0.10 and the shaft rotates 200 rpm?
A. 240 lb
B. 120 lb
C. 140 lb
D. 280 lb

86. The axial force required is 150 N when the capacity of the clutch is 8 kW at 500 rpm. What is the mean diameter of the active conical sections when the cone clutch has an angle of 10 degrees and coefficient of friction of 0.5?
A. 508 mm
B. 808 mm
C. 608 mm
D. 708 mm

(85.) $F_{BEARING} = \frac{F_T}{n_B} = \frac{2800\ lb}{2} = 1400\ lb$

$F_f = f F_B = (0.10)(1400\ lbs) = \boxed{140\ lbs}$

(86.) $T = \frac{n f F_a r_m}{\sin\alpha}$ $\qquad P = \frac{TN}{9.549 \times 10^6}$

$152{,}784 = \frac{(1)(0.5)(150)(d_m/2)}{\sin 10^\circ}$ $\qquad 8 = \frac{T(500)}{9.549 \times 10^6}$; $T = 152{,}784\ N\text{-}mm$

$\boxed{d_m = 708\ mm}$

87. What horsepower would be transmitted by a short shaft, 2 inches in diameter carrying two pulleys close to the bearings, if the shaft makes 360 rpm?

A. 50 hp
B. 76 hp
C. 48 hp
D. 89 hp

88. In sulfuric acid, which of the following is suitable for handling acid in concentrations up to 50% and at a temperature including the boiling point?

A. Hastelloy B
B. Inconel X
C. Inconel
D. Hastelloy A

$$P = \frac{D^3 N}{38} \rightarrow \text{SHORT SHAFT}$$

$$P = \frac{(2)^3 (360)}{38} = \boxed{76 \text{ HP}}$$

89. A 100-lb body is being hoisted by a winch, the tension in the hoisting cable being kept constant at 120 lb. Calculate its acceleration.
A. 6.44 ft/sq.s
B. 3.54 ft/sq. s
C. 5.48 ft/sq. s
D. 3.22 ft/sq.s

90. What is the circular pitch of a spur gear with clearance of 0.05 in?
A. 2
B. 4
C. 3
D. 1

$$T = W\left(1 + \frac{a}{g}\right)$$

$$120\ lb = 100\ lb\left(1 + \frac{a}{32.2}\right)$$

$$a = 6.44\ ft/s^2$$

$$P_D = \frac{\pi}{P_C}$$

$$P_C = \frac{\pi}{P_D}$$

$$P_C = \frac{\pi}{3.14}$$

$$= 1$$

$$c = \frac{0.157}{P_D}$$

$$0.05 = \frac{0.157}{P_D}$$

$$P_D = 3.14$$

91. What accounts for the backlash of spur gears?
   A. Both module and pitch line velocity
   B. Pitch line velocity
   C. Module
   D. Tooth profile

92. An aluminium [shear modulus = 2.8 x 10(raised to10) Pa] rod is 25 mm in diameter and 50 cm long. One end is rigidly fixed to a support. Compute the torque that must be applied at the free end to twist the rod 5.2° about its longitudinal axis?
   A. 107 N-m
   B. 260 N-m
   C. 804 N-m
   D. 195 N-m

$$\theta = \frac{584\,TL}{D^4 G}$$

$$5.2^\circ = \frac{584\,(T)(0.5\,m)}{(0.025\,m)^4\left(2.8\times10^{10}\right)\frac{N}{m^2}}$$

$$T = 195\ N\text{-}m$$

B. 280 N-m

93. Find the maximum tensile stress caused by an axial load of 500 lb and a torque of 600 in-lb acting on a 1 - inch - diameter solid shaft. Note: $S_{s_{max}} = 307$
   A. 3943 psi
   B. 3394 psi
   C. 637 psi
   D. 3075 psi

94. When a coil spring with a spring scale of 100 lb/in is compressed 1 1/4 inches, the coils are closed. The allowable shearing stress if 50,000 psi and the spring index is 8, the ends are squared and ground, and G = 12 x 10 (raised to 6) psi. Calculate the required wire diameter.
   A. 0.453
   B. 0.246 in.
   C. 0.342 in.
   D. 0.342

Continued on Page 11

(94.) $S = \frac{8KFC}{\pi d_w^2}$ $F = k\delta$

$$50{,}000 = 8\left(\frac{4(8)-1}{4(8)-4} + \frac{0.615}{8}\right)(100 \times 1.25)(8)$$

$$\frac{\pi d_w^2}{\pi d_w^2}$$

$d_w = 0.246$ in

(93.)

$$S_{TMAX} = \frac{S_T}{2} + \sqrt{\left(\frac{S_T}{2}\right)^2 + S_s^2}$$

$$S_{TMAX} = \frac{636.62}{2} + \sqrt{\left(\frac{636.62}{2}\right)^2 + 3055^2}$$

$= 3389.85$ psi

$$S_s = \frac{16T}{\pi d^3} = \frac{16(600)}{\pi(1\text{in})^3}$$

$S_s = 3055$ psi

$$S_T = \frac{F}{\frac{\pi}{4}d^2} = \frac{500\text{ lb}}{\frac{\pi}{4}(1\text{in})^2} = 636.62 \text{ psi}$$

95. A body hangs from an ideal spring. What is the frequency of oscillation of the body if its mass, m, is 0.015 kg, and k is 0.50 N/m?

A. 0.66 Hz
B. 0.92 Hz
C. 0.78 Hz
D. 0.351 Hz

$$f = \frac{1}{T} = \frac{1}{2\pi\sqrt{\frac{m}{k}}} = \frac{1}{2\pi\sqrt{\frac{0.015}{0.50}}}$$

$$f = 0.92 \text{ Hz}$$

96. A 8-ft-diameter spherical pressure vessel is made by bolting two hemispherical flanged sections together. How many 1-in diameter bolts are required to secure two halves if the pressure within the vessel is 25 psi? Use working stress of 15,000 psi and a cross-sectional area of 0.551 sq in for the bolts.

A. 24
B. 22
C. 20
D. 28

96.

$$n_B = \frac{F_T}{F_B}$$

$$F_T = PA = \left(25 \frac{\text{lb}}{\text{in}^2}\right)\left(\frac{\pi}{4}\left(8\text{ ft} \times \frac{12\text{ in}}{1\text{ ft}}\right)^2\right) = 57{,}600\pi \text{ lbs}$$

$$F_B = SA_B = \left(15{,}000 \frac{\text{lb}}{\text{in}^2}\right)\left(0.551 \text{ in}^2\right) = 8265 \text{ lbs}$$

$$n_B = \frac{57{,}600\pi}{8265} = 21.89 \approx \boxed{22}$$

97. When more than one spring or resisting member shares the load, the relative stiffness is the _____.
   A. normal stress C. stiffness
   B. rigidity D. modulus of elasticity

98. A coil spring 4 cm in outside diameter made of 5 mm wire is to support a mass of 45 kg, calculate the spring stress concentration factor.
   A. 1.213 C. 1.143
   B. 1.718 D. 1.071

$$C = \frac{D_m}{dw} \rightarrow do - dw$$

$$C = \frac{\left(4\,cm \times \frac{10\,mm}{1\,cm}\right) - 5\,mm}{5\,mm} = 7$$

$$K_W = \frac{4C-1}{4C-4} + \frac{0.615}{C} = \frac{4(7)-1}{4(7)-4} + \frac{0.615}{7}$$

$$= 1.213$$

99. A double threaded right- handed worm gear transmits 15 Hp at 1150 rpm. The pitch of the worm is 3/4 inches and pitch diameter of 3 inches. The pressure angle is 14.5 degrees and the coefficient of friction is 0.12. Compute for the tangential force on the worm, express the answer in pounds.

A. 840
B. 950
C. 498
D. 548

100. Find the force required to punch a 25-mm hole in a 20-gage (0.9525 mm) steel plate if the shearing strength of the material is 400 MN/m(squared).

A. 29.9 kN
B. 22.4 kN
C. 32.4 kN
D. 24.5 kN

$$P = \frac{TN}{63025}$$

$$15 = \frac{T(1150)}{63025}$$

$$T = 822 \text{ in-lb}$$

$$T = Fr$$

$$822 \text{ in-lb} = F\left(\frac{3}{2}\right)$$

$$F = 548 \text{ lb}$$

$$S = \frac{F}{\pi dt}$$

$$400 \frac{N}{mm^2} = \frac{F}{\pi (25 mm)(0.9525 mm)}$$

$$F = 29{,}923.67 \text{ N}$$

$$= 29.9 \text{ kN}$$