Republic of the Philippines
PROFESSIONAL REGULATION COMMISSION
Manila

BOARD OF MECHANICAL ENGINEERING

Registered Mechanical Engineer Licensure Examination
Wednesday, February 9, 2022 07:30 a.m. - 11:00 a.m.

MACHINE DESIGN, MATERIALS AND SHOP PRACTICE SET A

INSTRUCTION: Select the correct answer for each of the following questions. Mark only one answer for each item by marking the box corresponding to the letter of your choice on the answer sheet provided.
STRICTLY NO ERASURES ALLOWED. Use pencil No.2 only.

MULTIPLE CHOICE:

1. Which of the following is an example of accelerated strain aging in steel?
   A. Blue brittleness
   B. transition aging
   C. Brittle fracture
   D. corrosion cracking

2. What is 78% nickel, 14% chromium, 7% iron
   A. monel
   B. hastalloy
   C. inconel
   D. none of these

3. Type of bolt commonly used in the construction that is threaded in both ends
   A. stud bolt
   B. Acme threaded bolt
   C. square threaded bolt
   D. hex bolt

4. The ratio of lateral deformation to longitudinal deformation.
   A. stress
   B. strain
   C. Poisson's ratio
   D. strength

5. What's number 5 in a Mohr's scale ?
   A. Flour spar
   B. Apatite
   C. Quarts
   D. Gypsum

6. A method that does not require clamping, chucking, or holding round workpieces.
   A. centerless grinding
   B. chemical milling
   C. laser machining
   D. ultrafinishing

7. Removes heat by electrolysis in a high current deplating operation.
   A. Electrochemical machining
   B. electrospark machining
   C. Electronic erosion
   D. Electrical discharge machining

8. Also known as electrolytic grinding
   A. Laser grinding
   B. Ultranic grinding
   C. electrochemical grinding
   D. chemical milling

9. Manufactured from aluminum oxide have the same expected life as carbide tools but can operate at speeds from two to three times higher. They operate below 1100 C.
   A. Sintered carbides
   B. Diamonds
   C. Ceramic tools
   D. Cast nonferrous

10. The helical and herringbone gear teeth cut after heat treatment should have a hardness in the range of 210/300BHN. The pinion gear teeth hardness on the other hand, ideally/normally should be at how many BHN.
   A. 250/320
   B. 400
   C. 350/380
   D. 340/350

11. The planes of a crystalline lattice can be specified by
   A. Burger's vectors
   C. Fick's law

B. Taylor-Orowan dislocations D. Miller indices

12. Find the weight of the flywheel needed by a machine to punch 20.5 mm holes in 15.87 mm thick steel plate. The machine is to make 30 strokes per minute and a hole must be punched every stroke. The hole is to be formed during 30 degrees rotation of the puncher's crankshaft. A gear train with a ratio of 12 to 1 is to connect the flywheel shaft to the crankshaft. Let the mean diameter of a flywheel rim to be 91.44 cm. The minimum flywheel speed is to be 90% of the maximum and assume mechanical efficiency of the machine to be 80%.Assume an ultimate stress of 49000 psi.
A. 68 kg C. 90 kg
B. 97 kg D. 92 kg

13. A 2 inches circular shaft is stressed in transverse shear by a force of 25000 lbs. Determine the maximum shear stress?
A. 9600 psi C. 10600 psi
B. 8700 psi D. 11700 psi

14. A solid shaft 6 in. in diameter is coupled by bolts 1 ¼ in. in diameter with centers 5 inches from the axle. How many bolts are necessary?
A. 4 C. 5
B. 6 D. 7

15. Acceleration toward the center of rotation is
A. normal acceleration C. centripetal acceleration
B. Coriolis acceleration D. centrifugal acceleration

16. A carbide face milling cutter of 200 mm diameter is used to take one cut across the face of a block of aluminum which is 200 mm wide. The length of block is 450 mm. If a feed of 0.75 mm/rev is used, how long will it take to machine one cut on the block. The total travel is 12 mm. The cutting speed is 320 m/min.
A. 2.45 min C. 1.45 min
B. 2.09 min D. 1.22 min

17. The three-moment equation mau be used to anlyze:
A. tapered column C. composite beam
B. continuous beam D. axially end loaded beam

18. For a high corrosion resistant stainless steel, what minimum chromium content is required?
A. 8% C. 4.3%
B. 1.1% D. 5.8%

19. V-belts operate efficiently at speed of about (fpm)
A. 4500 C. 4400
B. 4200 D. 3600

20. A furnace used in melting non-ferrous metals
A. cupola furnace C. induction furnace
B. crucible furnace D. tempering furnace

21. A 30 mm HSS drill is used to drill a hole in a cast iron block 100 mm thick. Determine the time required to drill the hole if feed is 0.3 mm/rev. Assume an overall travel of drill as 4 mm. The cutting speed is 20 m/min.
A. 1.85 min. C. 2.85 min.
B. 1.99 min. D. 2.11 min.

22. The sum of the rake, clearance, and wedge angles is
A. 90 deg. C. 180 deg.
B. 45 deg. D. 75 deg.

23. Cut pieces from flat plates, strips and coil stock
A. shearing C. Bend allowance
B. Forming dies D. Spring back

24. A piece of stock 8" long is 4" diameter on one end and 1" diameter on the other end. The taper per foot is:

A. 4"
B. 4 -1/2"
C. 4 -1/4"
D. 4 -1/16"

25. A steel specimen is subjected to a tensile force of 400,000 lbs. If the poisson's ratio is 0.29, and the modulus of elasticity is 2.8×10^7 psi, find the dilatation,
A. 6.50×10^{-5} in
B. 7.65×10^{-5} in
C. 7.65×10^{-4} in
D. 6.50×10^{-4} in

26. It is process in which metal is dipped in dilute acid solutions to remove dirt, grease, and oxides.
A. Pickling
B. Polishing
C. Sheradizing
D. Pakerizing

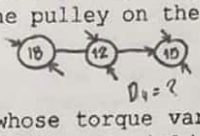
27. A flange coupling is to be designed, using 25 mm diameter bolts at a distance of 152 mm from the center of the shaft. Allowable shearing stress on the bolt is 103 MPa. If the shaft is to transmit 5,800 hp at a speed of 1,200 rpm, How many bolts are needed in the connection?
A. 2
B. 3
C. 4
D. 5

$$S_s = \frac{8T}{\frac{\pi}{4} d_b^2 D_{bc} N}$$

$$103 \times 10^6 = \frac{8(34916.08)}{\frac{\pi}{4}(0.026)^2(0.152 \times 2)(N)}$$

28. Poisson's ratio is the ratio of :
A. shear strain to compressive strain
B. elastic limit to compressive strain
C. lateral strain to longitudinal strain
D. elastic limit to proportional limit

29. A lineshaft runs at 360 rpm. An 18" pulley on the same shaft is belt connected to a 12" pulley on the countershaft. From a 15" pulley on the countershaft motion is transmitted to the machine. Compute/check the required of the pulley on the machine to give a spindle speed of 660 rpm.
A. 16"
B. 12 1/4"
C. 101/2"
D. 81/2"



$N_2 = 360.22$ 13.125
$N_3 = 443.5$ 11.70

30. The shaft whose torque varies from 2000 to 6000 in lbs has 1 1/2 in in diameter and 60000 psi yield strength. Compute for the shaft mean average stress.
A. 6036 psi
B. 6810 psi
C. 5162 psi
D. 5550 psi

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

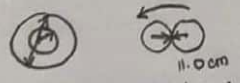
3018.05

31. What power would a spindle 55 mm in diameter transmit at 480 rpm. Stress allowed for short shaft is 59 newtons/mm^2
A. 45.12 kw
B. 50.61 kw
C. 45 Hp
D. 39.21 kw

$$P = \frac{D^3 N}{38}$$

9059.15

32. Two parallel shaft connected by pure rolling turn in the same direction and having a speed ratio of 2.75. what is the distance of the two shaft if the smaller cylinder is 22 cm. in diameter.
A. 16.60 cm
B. 30.25 cm
C. 25.25 cm
D. 19.25 cm



$N_1 D_1 = N_2 D_2$

$\frac{N_2}{N_1} = 2.75 = \frac{D_1}{D_2}$

60.5 = 30.25
11.0

33. Determine the torque received by the motor shaft running at 4250 rpm. Transmitting 11 Hp, through a 10 in diameter 20° involute gear. The shaft is supported by ball bearings at both ends and the gear is fixed at the middle of 8" shaft length
A. 163 in lb.
B. 167 in. lb
C. 132 in. lb.
D. 138 in. lb.

34. The maximum-strain theory which applies only in elastic range of stresses is also known as_____.
A. Hooke's Law
B. Saint Venant's Theory
C. Stress-strain Theory
D Cataligno's Theory ✗

35. Find the rim thickness for a cast iron flywheel with a width of 200 mm, a mean diameter of 1.2 m a normal operating speed of 300 rpm, a coefficient of fluctuation of 0.05 and which is capable of handling 3000 N-m of kinetic energy. Assume that the hub and arms represent 10% of the rim weight and the specific weight of cast iron is 7203 kg/m^3
A. 25.28 mm
B. 28.82 mm
C. 28.25 mm
D. 25.25 mm

$\frac{v_1+v_2}{2} = 76.2$ $v_1 = 0.802$ $v_2 = 0.89$

$v_1 = v_2(0.9)$ $KE = \frac{Wv^2}{g}$ $205J = \frac{W_R}{9.81}\left[[\pi(0.80)(2000)]^2 - [\pi(0.841)(1800)]^2\right]$

36. It is found that the shearing machine requires 205 Joules of energy to shear a specific gauge of sheet metal. The mean diameter of the flywheel is to be 76.2 cm. The normal operating speed is 200 rpm and slows down to 180 rpm during shearing process. The rim width is 30.48 cm and the weight of cast iron is 7,196.6 kg/m³. Find the thickness of the rim, assuming that the hub and arms account for 10% of the rim weight concentrated on the mean diameter.

A. 0.583 cm
B. 0.587 cm
C. 0.672 cm
D. 0480 cm

$W_R = 9.80 = W_r + W_{HA}$ $9.80 = 1.1\left[7.196.6(0.30048)(t)\right]$

37. Based on experience, what is the most economical design belt speed ?

A. 6000 to 7500 fpm
B. 3500 to 4700 fpm
C. 3000 to 5000 fpm
D. 5000 to 1000 fpm

38. The tension in the belt due to centrifugal force increasing rapidly above about how many fpm?

A. 1500 fpm
B. 3500 fpm
C. 3000 fpm
D. 2500 fpm

39. 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 screw and collar.

A. 13.438%
B. 15.530%
C. 14.526%
D. 12.526%

$\tan\alpha = \frac{L}{\pi D_m} = 88.92'$ $e = \left[\frac{\tan\alpha}{\tan(\alpha+\theta_f) + \frac{f_c D_c}{D_m}}\right]$ 0.093

40. If the principal stresses on a body are 400 psi, -700 psi, and 600 psi, what is the maximum shear stress?

A. 100 psi
B. 200 psi
C. 550 psi
D. 650 psi

$\eta_f = 1.20$ $e = \frac{WV}{2\pi T_{or} N}$ $T_e =$

41. Manufactured from aluminum oxide have the same expected life as carbide tools but can operate at speeds from two to three times higher. They operate below 1100 C.

A. Sintered carbides
B. Diamonds
C. Ceramic tools
D. Cast nonferrous

42. If a clearance of a cutting edge is 15 deg, the lip (wedge) angle in 75 deg, the rake angle will be

A. 80 deg
B. 10 deg
C. 70 deg
D. None of the above

43. The size of a grinding wheel is taken from

A. Diameter of a wheel
B. Width of face
C. Bore size
D. All of the above

44. For the accurate measurement of bores, the best instrument is

A. Vernier caliper
B. Plug gauge
C. Dial test indicator
D. Inside micrometer

45. Shaper tool bit should not extend in tool holder beyond

A. 5 mm
B. 25 mm
C. 15 mm
D. 50 mm

46. In a slotter the cutting speed depends upon

A. Material to be cut
B. Finish required
C. Material of the slotter tool
D. All of the above

47. Molybdenum steel standard designation is SAE_____

A. 88XX
B. 40XX
C. 48XX
D. 46XX

48. A research agency handling assistance to all foundry, machine shop and metallurgic plant operation.

A. MIRDC
B. DOST
C. all of these
D. BOI

49. In greater quantity, this element is harmful to the molten ferrous metal.
A. silicon
B. oxides
C. aluminum
D. sulfur

50. A turbine developing 15,000 Hp turns the shaft at 300 rpm. The propeller attached to this shaft develops a thrust of 150,000 lb. A hollow steel shaft having an outside diameter of 14 in. is to be used. Determine the inside diameter of the shaft if the maximum shearing stressed based on the torsion alone is not to exceed 7500 psi.
A. 9.59 in
B. 8.76 in
C. 10.59 in
D. 11.34 in.

51. The phenomenon of expansion or contraction of a material when subjected to a magnetic field.
A. Magnetostriction
B. Ferromagnetism
C. Piezoelectric effect
D. Superconductivity

52. The ratio of the perimeter of the extruded product to its cross sectional area.
A. extrusion ratio
B. shape factor
C. billet
D. extrusion constant

53. A solid shaft from a turbine is to transmit 2000kW at 300 rpm. Calculate the diameter of the shaft allowing a stress of 35 MPa.
A. 97.47 mm
B. 94.77 mm
C. 77.94 mm
D. 74.97 mm

54. A hollow bronze tube has an outer diameter of 2 in. and an inner diameter of 1 ½ in. and is 12 in. long. A crank 15 in. long is keyed to one end , and the other end is held rigidly. The modulus of rigidity is 10,000,000 psi. The force required at the end of the crank is equivalent to:
A. 900 kg
B. 887 kg
C. 8770 kg
D. 788 kg

55. A 15/16 - in wide key has a depth of 5/8 in. It is 12 inches long and is to be used on a 200 hp, 1160 rpm, squirrel -cage induction motor. The shaft diameter is 3 7/8 inches. The maximum running torque is 200% of the full-load torque. Compute the maximum torque.
A. 17,330 in-lb
B. 733,211 in-lb
C. 37,210 in-lb
D. 21,733 in-lb

56. The process by which the length of a workpiece is increased by reducing its cross-sectional area
A. Drawing out
B. Jumping
C. Upsetting
D. Drifting

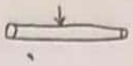
57. It has good machinability, however it requires a coolant type cutting fluid because of the danger of explosion and fire.
A. Tungsten
B. Zirconium
C. Tantalum
D. Wrought copper

58. An oxidation process in which the workpiece surfaces are converted to a hard and porous oxide layer that provides corrosion resistance and a decorative finish.
A. Electroforming
B. Electroless plating
C. Hot dipping
D. Anodizing

59. Like the Soderberg criterion, the Goodman criterion should be used with all of the following materials except.
A. steel
B. aluminum
C. titanium
D. cast iron

60. A hollow bronze tube has an outer diameter of 2 in. and an inner diameter of 1 ½ in. and is 12 in. long. A crank 15 in. long is keyed to one end , and the other end is held rigidly. The modulus of rigidity is 10,000,000 psi. Compute for J ?
A. 3.178 in.^{4}
B. 1.0738 in.^{4}
C. 3.781 in.^{4}
D. 1.738 in.^{4}

61. A simple beam, 48 in. long , with a static load of 6000 pounds at the center is made of C1020 structural steel. What is the maximum moment of the beam in in - lb?
A. 72,000
B. 80,000
C. 50,000
D. 60,000



62. If there are 860 persons occupying the building other than the first floor, then how many elevators are required?
A. 6
B. 8
C. 4
D. 10

63. Taps are resharpened by grindings
A. Flutes
B. Diameter
C. Threads
D. Relief

64. Compute the lineshaft diameter to transmit 12 HP at 180 rpm with torsional deflection of 0.80 degrees per ft length.
A. 3 in.
B. 2.35 in.
C. 5 cm
D. 62 mm

$HP = \left(\frac{d}{40}\right)^4 N$

$\theta = \frac{TL}{JG}$ $\theta = \frac{32M}{\pi d^3}$

65. A truck skids to a stop 60 m after the application of the brakes while traveling at 90 km/hr. What is the acceleration in m/sec^2?
A. $-5.21\ m/s^2$
B. -7.06
C. 6.36
D. 5.76

66. In which screw thread the side = width of flat = width of space=0.5
A. Knuckle
B. Square
C. Buttress
D. Acme

67. A stud is which
A. have threads in one end
B. inserted in a plane hole
C. require a nut
D. none of the above

68. '18-8' stainless steel means
A. 18% Tungsten and 8% Chromium
B. 18% Nickel and 8% Chromium
C. 18% Chromium and 8% Nickel
D. 18% Chromium and 8% Cobalt

69. Which is the lightest metal?
A. Lead
B. Aluminum
C. G.I. Sheet
D. Cast Iron

70. A three extension coil springs are hooked in series that support a single weight of 100 kgs. The first spring is rated at 0.400 kg/mm and the other 2 lower spring is rated at 0.64 kg/mm. Compute the total deflection.
A. 563 mm
B. 156 mm
C. 268 mm
D. 550 mm

71. The power that can be transmitted by a spindle of 55 mm diameter running at 1200 rpm and allowable stress of 5 MPa
A. 10.3 kw
B. 25.0 kw
C. 20.5 kw
D. 50.2 kw

72. Compute the circular path (in inch) of a pair of gears having a ratio of 4 and a center distance of 10.23. Each gear has 72 teeth and pinion has 18 teeth.
A. 0.8095
B. 0.8035
C. 0.7825
D. 0.8085

73. A 2 in single threaded, square screw has a TPI of 2 and coefficient of friction of 0.2. What is the efficiency?
A. 30.32%
B. 55.15%
C. 34.32%
D. 44.22%

74. Determine the bending stress of wire rope with drum diameter of 7.8" and wire diameter of 0.987 inch.
A. $S_b = 37.96x10^4\ psi$
B. $S_b = 34.96x10^4\ psi$
C. $S_b = 36.6x10^4\ psi$
D. $S_b = 35.96x10^4\ psi$

75. One of the causes of spur gear tooth breakage is the unbalanced laod on one end of the tooth that results in higher stresses than when the load is evenly distributed to minimize this problem, the face width "b" should not be greater than the thickness (or pitch) of the tooth in the absence of test values, the following can be a guide.

A. $2.5P_c < b < 4P_c$
B. $2.0P_d < b < 4P_d$
C. $2.5P_d < b < 4P_d$
D. $2.0P_c < b < 4P_d$

76. In the gear design, the total work load must be equally shared by its arms. Rim must be rigid to support thee arms and also the head is recommended for its stiffening value. The assumption in the detailed design of rim thickness and depth of bead is _____ circular pitch (PC).

A. 0.65
B. 0.56
C. 0.50
D. 0.44

77. What is the stress to strain ratio within the elastic limit?

A. elastic limit
B. modulus of elasticity
C. elasticity
D. compressive ratio

78. Height of tooth above the pitch circle or the radial distance between pitch circle and top land of the tooth

A. top root
B. addendum
C. land
D. hunting tooth

79. The ratio of moment of inertia on a cross-section of a beam to its section modulus is $I/c = Z$

A. a measure of distance
B. equal to the radius of gyration and compression
C. multiplied by the bending moment of inertia to determine the yield stress
D. equal to the area of the cross-section and tension

80. A usual ratio of soluble oil and water used in coolant is

A. 1:10
B. 1:20
C. 10:1
D. 20:1

81. Which of the following is not a structural class of steel ?

A. low carbon steel
B. high chrome alloy steel
C. tool and die steel
D. high strength low alloy steel

82. For a given r.p.m., if the diameter of a twist drills called

A. Increase
B. Same
C. Decrease
D. None of the above

83. The formula to find out the number of turn of the crank simple indexing is

A. T=20/N
B. T=40/N
C. T=N/20
D. T=N/40

84. In a standard dividing head the ratio between the worm wheel and the worm is

A. 10:1
D. 30:1
C. 20:1
D. 40:1

85. The product of the resultant of all forces acting on a body and the time that the resultant acts :

A. angular impulse
B. linear impulse
C. angular momentum
D. linear momentum

86. The standard ratio of cutting to return stroke in shaper is

A. 3:1
B. 2:3
C. 1:3
D. 3:2

87. An alloy of copper and tin

A. monel metal
B. bronze
C. brass
D. Babbitt

88. The ratio of the height of a column to the least radius of gyration of its cross-section is called

A. moment of inertia
B. section modulus
C. slenderness ratio
D. Euler factor

89. Height of gear tooth below the pitch circle or the radial clearance between pitch circle and bottom land of the tooth
A. addendum
B. land
C. top root
D. dedendum

90. The number of whistles to signal a crane operator to lower a boom
A. one
B. two
C. three or more
D. none of these

91. A bevel gear having pitch cone angle of 45^0
A. miter
B. helical
C. crown
D. worm

92. In straddle milling the number of cutters used to cut
A. one
B. three or more
C. two
D. any of these

93. The process of working metals by the application of pressure or by hammering
A. welding
B. brazing
C. blacksmith
D. forging

94. Type of key which is chamfered at the bottom
A. rollpin
B. barth key
C. woddruff key
D. gib-head taper key

95. Jig bushings are generally made of
A. Mild steel
B. Tool steel
C. Cast iron
D. Brass

96. Fixture clamps are generally made of
A. High carbon steel
B. High speed steel
C. Case hardened mild steel
D. Alloy steel

97. While soldering the flux is used because
A. It assists for quick melting and increasing the fluidity of solder.
B. It saves the part from the oxidation.
C. It takes the molten metal on all surfaces.
D. All of the above.

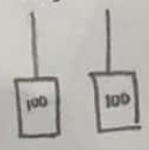
98. Which of the following groups of pipe sizes is correct?
A. ¼, ½, ¾, 7/8, 1
B. ¼, 3/8, ½, 5/8, ¾, 1
C. ¼, 3/8, ½, ¾, 1
D. ¼, ½, 5/8, ¾, 1

99. Determine the width of the leaves of a six-leaf steel cantilever spring 13 in. long to carry a load of 375 lb with a deflection of 1¼ in. The maximum stress in this spring is limited to 50,000 psi.
A. 2.01 in.
B. 2.54 in.
C. 1.93 in.
D. 1.54 in.

$6FL = \sigma b t^2$

$6(375)(13) = 50{,}000(b)(6)(0.\text{DF})$

100. Two masses of 100 kg are suspended by wires that are five mm in diameter. One wire is of aluminum and the other is of steel. The wires are ten meters long. How much lower will the mass held by the aluminum wire be?
A. 4.37 mm
B. 4.87 mm
C. 5.37 mm
D. 5.87 mm



$E\delta t = \sigma b L^2$

$\frac{30\times10^6(1.25)(t)}{50{,}000(13)} = b$

$57.7\,t = b$

END

SUBMIT THIS TEST QUESTION SET TOGETHER WITH THE ANSWER SHEET TO YOUR WATCHERS. BRINGING THE TEST QUESTION SET OUT OF THE ROOM WILL BE A GROUND FOR DISCIPLINARY ACTION.