Republic of the Philippines
PROFESSIONAL REGULATION COMMISSION
Manila

BOARD OF MECHANICAL ENGINEERING

Registered Mechanical Engineer Licensure Examination
Sunday January 20, 2019 01:30 p.m. 06:30 p.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. Determine the shear stress at the inside surface of a hollow circular shaft where the torque is 8000 ft-lb of inside and outside diameters are 2 in and 4 inches respectively.

A. 4.1 Mpa
B. 28.1 MPa *
C. 5.5 ksi
D. 12.4 ksi

2. What material which usually pre-heating is very essential in welding?
A. cast iron
B. high carbon steel
C. brass
D. stainless steel *

3. When a nut is tightened by placing a washer below it, the bolt will be subjected to which stress?
A. tensile stress *
B. compressive stress
C. shear stress
D. circumferential stress

4. A solid steel shaft having a diameter of 3 inches twists through an angle of 5 deg in 20 ft of length because of the action of a torque. Determine the maximum shearing stress. Note: shear modulus for steel is 12 x 10 (raised to 6) psi.

A. 45.15 Mpa *
B. 6550 kPa
C. 5409 psi
D. 7300 psi

5. Proof strength is related to which of the following?

A. elongation *
B. necking
C. yielding
D. fracture

6. What is the most abundantly used material in industry?

A. cast iron
B. mild steel *
C. medium carbon steel
D. Aluminum

7. What is the maximum power of a solid steel shaft 2 inches in diameter can transmit at 200 rpm if the maximum permissible shearing stress is 68.93 Mpa.
A. 40 hp
B. 30 hp
C. 50 hp *
D. 35 hp

8. How many 3/8-inch bolts are arranged in a 5-in-diameter bole circle would be required to transmit 100 hp at 315 rpm through a flange coupling? The maximum permissible stress is 68.93 Mpa.

A. 10 bolts
B. 8 bolts *
C. 12 bolts
D. 6 bolts

9. A pipe for conveying water to a hydroelectric turbine operates a head of 300 ft. If the diameter of the pipe is 762 mm and the allowable stress is 8000 psi, what is the wall thickness required?

A. 0.244 ft
B. 2.44 cm
C. 6.2 mm *
D. 0.43 in

10. If the following solid shaft diameters, which is the smallest that can be used for the rotor of a 6 hp motor operating at 3500 rpm, if the maximum shear stress for the shaft is 8500 psi?

A. 5/16 in
B. 3/8 in
C. 1 in
D. ½ in*

11. A thin hollow sphere of radius 10 in and thickness 0.1 in is subjected to an internal pressure of 100 psig. The maximum normal stress on an element of the sphere is:

A. 2500 psi
B. 5000 psi *
C. 7,570 psi
D. 10,500 psi

12. In designing a cylindrical pressure tank 3 feet in diameter, a factor of safety of 2.5 is used. The cylinder is made of steel (yield stress = 30 ksi) and will contain pressures up to1000 psi. What is the required wall thickness, t, based on circumferential stress considerations?

A. 0.725 in.
B. 1.50 in. *
C. 3.25 in.
D. 3.15 in.

13. What is the percentage (range) of carbon present in mild steel is

A. less than 0.008
B. 0.008 0.30 *
C. 0.30 0.80
D. 0.8 2.11

14. Ceramic cutting tools are made of which of the following?

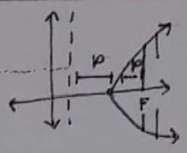
A. mixture of oxides of aluminium
B. silicon oxides
C. titanium oxide
D. tungsten carbide

15. A flywheel weighing 6 kN has a mean diameter of 90 cm. The maximum speed of the flywheel is 7 rev/sec slowed down to 4 rev/sec during the shearing process. Determine the energy released by the flywheel.

A. 7956 kg-m
B. 8145 kg-m
C. 3214 kg-m
D. 8241 kg-m *

16. Two parallel shaft connected by pure rolling turn in the same direction and having a speed ratio of 4. What is the distance of the two shaft if the small cylinder is 8 cm?

A. 11 cm
B. 12 cm *
C. 19 cm
D. 21 cm



17. What modulus of elasticity in tension is required to obtain a unit deformation of 0.00107 m/m from a load producing a unit tensile stress of 50, 000 psi?
   A. 3.45×10^7 psi
   B. 46.7×10^7 psi
   C. 46.7×10^6 psi *
   D. 4.67×10^6 psi

18. Determine the bursting steam pressure of a steel plate with a diameter of 12 in. and made of ¼ in steel plate. The joint efficiency is at 75% and the tensile strength is 55 ksi.
   A. 3, 440 psi *
   B. 4, 427 psi
   C. 4, 340 psi
   D. 1, 127 psi

19. What is the working strength of a 2 in bolt which is screwed up tightly in a packed joint when the allowable working stress is 11,000 psi?
   A. 12,400 lb
   B. 12,500 lb
   C. 18,700 lb *
   D. 20,500 lb

20. All four compression coil spring support one load of 700 kg/mm. All four springs are arranged in parallel and rated same at 0.609 kg/mm. Compute the deflection in mm.
   A. 264
   B. 247
   C. 568
   D. 287 *

21. A body weighing 1000 lb falls 6 inches and strikes a 2000 lb per in spring. The deformation of the spring is:
   A. 4 in
   B. 2 in
   C. 3 in *
   D. 5 in

22. A 60 inch diameter steel pipe, 3/8 inch thick, carries water under a pressure head of 550 ft. Determine the hoop stress in the steel.
   A. 24,310 psi
   B. 34,780 psi
   C. 19,066 psi *
   D. 13,920 psi

23. Height of tooth above 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

24. A cylindrical aluminum bar 1.0-in-diameter and 10 inches long is to fit snugly in a steel collar when the bar is subjected to an axial compressive force of 10,000 lb. How much larger in diameter should the collar be? Note: E = 10 x 10(6) psi and poisons ratio = 0.33.
   A. 0.0019 in
   B. 0.00032 in
   C. 0.0024 in.
   D. 0.00042 in. *

25. The pressure within the cylinder of a hydraulic press is 1000 psi. Cylinder diameter is 10 inches. Determine the thickness of the cylinder wall, allowing a tensile stress of 2,500 psi.
   A. 2.77 in *
   B. 4.2 in
   C. 3.5 in
   D. 1.25 in

26. The ratio of the pitch diameter in inches to the number of teeth
   A. pitch circle
   B. English module *
   C. module
   D. pitch diameter

27. The distance between similar, equally-spaced tooth surfaces in a given direction and along a given line.

A. pitch circle
B. pitch plane
C. pitch *
D. pitch diameter

28. The maximum moment induced in a simply supported beam of 20 ft span, by a 2000 pound load at midspan is
A. 105,000 ft lb
B. 16,000 ft lb
C. 32,000 ft lb
D. 10,000 ft lb *

29. Determine the length of belt needed for a two flat belt pulleys having a diameter of 70 cm and 30 cm. The center distance is 400 cm and pulleys rotate in same direction. Assume power transmitted is 10 hp at 200 rpm.
A. 958 cm *
B. 795 cm
C. 659 cm
D. 985 cm

30. A round steel bar 12 inches long is to withstand a dead load of 40,000 lb in compression. The rod must not shorten more than 0.004 inch and have a factor safety of at least 10. Assume the ultimate strength of the material to be 110,000 psi and modulus of elasticity to be 15,500,000 psi. Determine the diameter of the rod.
A. 2.41 in.
B. 3.14 in *
C. 1.14 in.
D. 4.23 in.

31. How long will it take to saw a rectangular piece of steel plate size ½ x 4 x 8 the length of cut is 4 ft. The power hacksaw makes 120 rpm and the feed per stroke is 0.008 in.?
A. 45 min.
B. 0.83 hr *
C. 32 hr
D. 42 min.

32. Find the torsional moment in N-m developed when the shaft delivers 40.2 hp at 260 rpm.
A. 901 x 10 to the 3rd power
B. 901 x 10 to the 2nd power
C. 1102 x 10 to the 2nd power
D. 1102 x 10 to the 3rd power *

33. Compute how many ¼ inch diameter set screws required to transmit 3 HP at a shaft speed of 900 rpm. The shaft diameter is 1 ¼ in
A. 2
B. 3
C. 4 *
D. 2.5

34. A pair of gear and pinion having a ratio of 4 with the gear having 100 teeth and the pinion with 25 teeth. Find the circular pitch, if the center distance is 15 and the pitch is at 6.
A. 0.94
B. 0.754 *
C. 0.610
D. 0.552

35. A gear of 80 teeth and a pinion of 20 teeth has a gear and pinion ratio of 4. Find the center distance, in inches, if the circular pitch is 0.885.
A. 14.1 *
B. 15.1
C. 16.1
D. 17.1

36. The section modulus of a circle of radius 5 cm is equal to:
A. 58.2 cm^3
B. 78.2 cm^3
C. 98.2 cm^3 *
D. 108.2 cm^3

37. A hollow shaft with outside diameter of 14 cm and wall thickness of 0.08 cm transmits 200 kW at 400 rpm. What must be the angular deflection of the shaft if the length is 5 meters? Take G = 12,000,000 psi.

A. 0.019 deg
B. 1.14 deg *
C. 1.94 deg
D. 2.44 deg

38. Compute the safe wall thickness of a 90 cm diameter steel tank. The tank is subjected to 7 MPa pressure and the steel material has yield stress of 220 MPa. Use a factor of safety of 3.

A. 4.3 cm *
B. 3.8 cm
C. 3.2 cm
D. 2.5 cm

39. The principal material used in high production metal working tools.

A. hyper-Eutectoid
B. Lead
C. high speed steel *
D. high speed carbon

40. A bolt has a tensile load of 300 lbs. The bolt is made of SAE 1040 material with Sy = 55 ksi, what is the stress area of the bolt?

A. 0.1023 in^2 *
B. 0.1230 in^2
C. 0.327 in^2
D. 0.5190 in^2

41. With an electric arc welding rate rate of 18 in/min, how long will it take to weld a ½ in. thick plate by 3 ft long seam?

A. 3 min.
B. 2 min. *
C. 1.5 min.
D. 4 min.

0.375

42. Determine the power transmitted, in kW, by a main power transmitting steel shaft with 2 3/8 inches in diameter using SAE 1060 material mounting a 12 inches pulley at a speed of 170 rpm.

A. 21.3 *
B. 25.8
C. 28.5
D. 0.75

43. Determine the polar section modulus, Z_p (in^3) of a shaft delivering 5 hp at 150 rpm. The diameter of the shaft is 1 inch and allowable stress of 6000 psi.

A. 0.175
B. 0.196 *
C. 0.489
D. 0.895

44. Compute the deflection of a 20 coils helical spring having a load of 120 kgs. The modulus of elasticity in shear of spring is 98 GPa, outside diameter of 10 cm and wire diameter of 10 mm. The spring is squared and ground ends.

A. 162.1 mm
B. 154.4 mm
C. 134.1 mm
D. 126.1 mm *

45. What is the root diameter of a 1-in coarse-thread (Unified and American National) series screw having 8 threads per inch.

A. 0.8376 in *
B. 0.9222 in.
C. 0.8035 in
D. 0.7987 in.

46. A steel rod 30 ft long used in a control mechanism must transmit a tensile force of 980 lb without stretching more than 1/8 in. nor exceeding an allowable stress of 20,000 psi. What must the diameter of the rod be? (E = 30 x 10^6 psi)

A. 1/4 in
B. 3/8 in *
C. 1/2 in
D. 3/4 in

47. What is the root area of a 1-in coarse-thread (Unified and American National) series screw having 8 threads per inch.
A. 0.4245 sq. in
B. 0.6855 sq. in
C. 0.5510 sq. in. *
D. 0.9810 sq. in

48. What is the thickness of a module 6 tooth measured along the pitch circle?
A. 18.85 mm *
B. 12.45 mm
C. 0.523 mm
D. 1/6 mm

49. A steel bar initially free of stress, is held between rigid supports. Determine the stress in the bar if the temperature drops 130 deg F. ($k = 6.5 \times 10^{-6}$ per deg F)
A. 11,400 psi
B. 15,600 psi
C. 20,600 psi
D. 25,400 psi *

50. A 20-tooth 5 diametral pitch gear meshes with a 63-tooth gear. Find the value of the standard distance.
A. 8.3 in *
B. 2.0 in.
C. 6.3 in.
D. 4.0 in.

51. How do you call the forming operations above the recrystallization temperature?
A. hot working *
B. recovery stage
C. cold working
D. Austempering

52. A draft horse walks a steady pace of 3 miles per hour. What steady force must he exert if the power output is exactly 1 horsepower?
A. 250 lb
B. 125 lb *
C. 400 lb
D. 100 lb

53. A plate clutch with a single friction surface of 10 inch outside diameter and 4 inch inside diameter. If the uniform wear theory is valid, find the torque the clutch will carry the total axial force of 5000 lb.
A. 2550 in-lb
B. 3714 in-lb
C. 3500 in-lb *
D. 4500 in-lb

54. A plate clutch with a single friction surface of 10 inch outside diameter and 4 inch inside diameter. If the uniform pressure theory is valid, find the torque the clutch will carry the total axial force of 5000 lb.
A. 2550 in-lb
B. 3714 in-lb *
C. 3500 in-lb
D. 4500 in-lb

55. Determine the number of leaves of a 13 in. long steel cantilever spring to carry a load of 375 lb with a deflection of 1.25 in. Note: the maximum stress of this spring is limited to 50 ksi with a dimension of width equal to 1.93 in and 0.225 in thickness.
A. 6*
B. 8
C. 10
D. 4

56. A spring with 12 active coils and a spring index of 9 supports a static load of 220 N with a deflection of 12mm. The shear modulus of spring material is 83 Gpa. Calculate the theoretical wire diameter.

A. 15 mm *
B. 16 mm
C. 18 mm
D. 19 mm

57. A mass of 0.025 kg is hanging from the spring whose spring constant is 0.44 N/m. If the mass is pulled down and released, what is the period of oscillation?

A. 1.50 s *
B. 1.2 s
C. 2.1 s
D. 0.50 s

58. 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

59. 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 *

60. Ratio of the angle of action to the pitch angle

A. contact ratio *
B. approach ratio
C. ratio of gearing
D. module

61. The use of hardened steel for the mating metal gear appears to give the best results and longer operational life. The usual hardness is in the range of

A. over 600 BHN *
B. 300 to 400 BHN
C. below 350 BHN
D. over 400 BHN

62. Which of the following is the maximum values of Poisson s ratio for an elastic material?

A. 0.85
B. 0.50 *
C. 0.90
D. 0.70

63. Continuous stretching under load even if the stress is less than the yield point.

A. plasticity
B. elasticity
C. creep *
D. ductility

64. Which of the following is the range of the percentage of carbon in grey cast iron?

A. 1 to 3%
B. 1.5 to 7.5 %
C. 3 to 4% *
D. 8 to 10%

65. Why are alloys extensively used in industry?

A. because they are sufficiently soft
B. because they are malleable
C. because they have good strength *
D. because they are ductile

66. The depth of a blind hold can be measured by

A. steel scale
B. vernier caliper *
C. micrometer
D. slip gauges

67. Which of the following is the following approximate thickness where plain butt welding process is used?

A. 10 mm thickness
B. 25 mm thickness *
C. 15 mm thickness
D. 75 mm thickness

68. The following statement is wrong about effect of cold working:

A. Good surface finish
B. Increase in hardness
C. Increase in yield strength
D. Increase in ductility *

69. The process of making angles, channels, I-sections etc. of steel is known as

A. casting
B. extrusion
C. rolling mill *
D. forging

70. Given the modulus of elasticity 30 x 10 (raised to 6)psi (steel)and Poisson s ratio of 0.28 calculate the shear modulus of elasticity.

A. 11.7 x 10 (raised to 6) psi *
B. 10.45 x 10 (raised to 6) psi
C. 12.45 x 10(raised to 6) psi
D. 9.45 x 10 (raised to 5 psi)

71. Calculate the required punching force for a round hole (0.375 in.) of aluminum with ultimate shear strength of 35,000 psi and thickness of 0.25 in.

A. 20.6 kN
B. 91.74 kN *
C. 100.54 kN
D. 82.5 kN

72. During the filing operation, the following precaution must be observed.

A. Do not rub fingers over the work. *
B. Do not rub fingers over the file.
C. Apply equal pressure during forward and backward stroke.
D. Clean the file frequently.

73. Which of the following forging process is used for making bolt heads?

A. upsetting *
B. drifting
C. swagging
D. fullering

74. A high-speed steel cutting tool is used on the following type of machine tool

A. grinders
B. honing machine
C. shaping machine *
D. lapping machine

75. The size of a shaper is specified by which of the following?

A. power of the motor
B. length of stroke *
C. size of table
D. dimensions of the vice used for holding the job

76. Which of the following is the standard point angle of a drill?

A. 60°
B. 90°
C. 118° *
D. 72°

77. Pipes subjected to very high pressure are made by:

A. extrusion process *
B. Bessemer process
C. sand casting
D. forging

78. Gears from sheet metal for mass production are produced by following method:

A. gear milling
B. gear shaping
C. stamping *
D. casting

79. Which of the following is the other name for mild steel?

A. low-carbon steel *
B. medium-carbon steel
C. high-carbon steel
D. alloy steel

80. Which is the most commonly used material for making jigs and fixtures?

A. brass
B. wrought iron
C. steel *
D. aluminium

81. A steel pipe is to be used to support a weight of 130 kN. The pipe has outside diameter of 100 mm, inside diameter of 90 mm, an area of 1500 sq.mm and a moment of inertia of 1.7 x 10(raised to 6) mm(to the 4th). Find the maximum length of the pipe considering that E = 210 Gpa and the yield stress is 250 Mpa.

$P=(\pi^2 EI)/(2L)^2$

A. 2.90 m
B. 3.40 m
C. 2.60 m *
D. 4.20 m

82. What is the natural frequency of an oscillating body whose period of oscillation is 1.2 s?

$\frac{2\pi}{1.2s} = 5.2 \frac{rad}{sec}$

A. 3.5 rad/s
B. 5.2 rad/s *
C. 2.7 rad/s
D. 4.2 rad/s

$1.2\,s \quad \frac{1\,rev}{2\pi}$

1.2 S

83. A welding operation in which a non-ferrous filler metal melts at a temperature below that of the metal joined but is heated above 450°C.

A. arc welding
B. spot welding
C. brazing *
D. butt welding

84. A kind of gear used to transmit motion from one shaft to another shaft at an angle to the first.

A. spiral gear
B. helical gear
C. worm gear
D. bevel gear *

85. The torsional deflection of steel shaft is 0.6 deg per meter length. The shear stress is 60 MPa. Compute the diameter of the shaft in mm. Steel modulus of elasticity is 79 GPa.

A. 90 mm
B. 105 mm
C. 130 mm
D. 145 mm *

86. What is the size of an air cylinder operating at 10 bar with a required force of 7854 N? Use a load ratio of 90%. Load ratio means the ratio of required force and theoretical force.

A. 100 mm
B. 105 mm *
C. 150 mm
D. 300 mm

87. A total deformation measured in the direction of the line of stress.

A. Stress
B. endurance limit
C. strain *
D. Poisson s ratio

88. A group of thin steel strips used for measuring clearances.

A. feeler gage *
B. micrometer
C. tachometer
D. caliper

89. A circle the radius of which is equal to the distance from the gear axis to the pitch point.

A. pitch circle *
B. base circle
C. root circle
D. outside circle

90. Cast iron flywheels are commonly designed with factor of safety of:

A. 9 to 12
B. 10 to 13 *
C. 8 to 11
D. 7 to 10

91. In a stress-strain diagram, what is the correct term for the stress level at ϵ= 0.20% offset?

A. the elastic limit
B. the offset rupture stress
C. the plastic limit
D. the offset yield stress *

92. A specimen is subjected to a load. When the load is removed, the strain disappears. From this information, which of the following can be deduced about this material?

A. It is elastic.*
B. It is plastic.
C. The material has modulus of elasticity.
D. The material is resilient

93. How do you call a steel with 0.8 % carbon and 100% pearlite?

A. Austenite
B. Hyper-eutectoid
C. Solidus
D. Eutectoid *

94. In case of gears the addendum is given by:

A. one module *
B. 1.57 x module
C. 2.16 x module
D. 1.25 / module

95. How do you call a cam where in the follower reciprocates or oscillates in a plane parallel to its axis?

A. circular cam
B. cylindrical cam *
C. reciprocating cam
D. oscillating cam

96. What is the usual value of helix angle of a drill?

A. 120 degrees
B. 60 degrees
C. 110 degrees
D. 30 degrees *

97. Cutting speed for some materials are as under which one of the following could be cutting speed for brass?

A. 30 m/min
B. 80 m/min
C. 40 m/min *
D. 50 m/min

98. A prismatic bar at 50 deg F is imbedded in a rigid concrete wall. The bar is 40 in long, and has a cross sectional area of 4 sq. in. What is the axial force in the bar if it is temperature is raised to 100 deg F? Note: the coef of thermal expansion is 5 x 10 (raised to 6)/ deg F and the modulus of elasticity is 32 x 10 (raised to 6) psi.

A. 32 kips *
B. 45 kips
C. 205 kips
D. 204 kips

99. In usual spur gearing, which of the following statement(s) is correct?

A. Pitch circle and base circle are the same
B. Working depth includes the clearance
C. Tooth outline are usually involute curves *
D. Tooth outline are usually cycloidal curves

100. The deformation that results from a stress and is expressed in terms of the amount of deformation per inch.

A. elongation
B. poisson s ratio
C. strain *
D. elasticity

*** 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.