Board Exam Desk

Mechanical Engineering Reviewer

Mechanical Engineering Licensure Examination | PRC | 120 original questions

2026 Edition | Updated November 2026

Original board-style practice questions with an answer key.

Practice questions

Mathematics, Engineering Economics and Basic Engineering Sciences

1. An engineer models a calibration curve and needs the roots of 2x^2 - 7x + 3 = 0. What are they?

A. x = -3 and x = -0.5
B. x = 3 and x = 0.5
C. x = 1.5 and x = 1
D. x = 6 and x = 1

2. The displacement of a slider is s(x) = x^3 - 4x^2 + 5x. What is ds/dx at x = 2?

A. 2
B. 1
C. 4
D. -3

3. Evaluate the definite integral of (x^2 + 2x) dx from x = 0 to x = 3.

A. 15
B. 12
C. 21
D. 18

4. A triangular gusset plate has sides of 7 cm, 8 cm and 9 cm. What is its area?

A. 28.00 cm^2
B. 26.83 cm^2
C. 31.50 cm^2
D. 24.25 cm^2

5. Two fair dice are rolled once. What is the probability that the sum is exactly 8?

A. 1/6
B. 1/9
C. 5/36
D. 7/36

6. A plant manager must form a 4-member safety committee from 9 qualified engineers. How many different committees are possible?

A. 3024
B. 84
C. 126
D. 36

7. Solve for x in 3^x = 50.

A. 3.561
B. 16.667
C. 3.912
D. 1.699

8. What is the perpendicular distance from the point (3, -2) to the line 4x + 3y - 12 = 0?

A. 1.2 units
B. 2.4 units
C. 6.0 units
D. 3.6 units

9. A spare-parts stockroom adds 5 bins in week 1, 9 in week 2, 13 in week 3, and so on. How many bins are added in total over 20 weeks?

A. 81
B. 780
C. 940
D. 860

10. What is the radius of the circle x^2 + y^2 - 6x + 8y - 11 = 0?

A. 3.32
B. 5
C. 6
D. 7

11. What is the magnitude of the complex product (3 + 4i)(1 - 2i)?

A. 7.00
B. 5.00
C. 15.00
D. 11.18

12. A quantity decays according to dy/dt = -0.2y with y(0) = 50. What is y when t = 5?

A. 40.00
B. 30.00
C. 18.39
D. 25.00

13. PHP 100,000 is deposited at 8% nominal interest compounded quarterly. What is the amount after 5 years?

A. PHP 140,000.00
B. PHP 148,594.74
C. PHP 146,932.81
D. PHP 148,024.43

14. A lender quotes 12% per year compounded monthly. What is the effective annual rate?

A. 12.00%
B. 12.68%
C. 12.36%
D. 12.55%

15. A heat-recovery retrofit saves PHP 25,000 at the end of each year for 10 years. At 9% interest, what is the present worth of the savings?

A. PHP 160,441.44
B. PHP 250,000.00
C. PHP 379,823.24
D. PHP 277,777.78

16. A compressor costs PHP 850,000, has a salvage value of PHP 50,000 and a life of 8 years. Using straight-line depreciation, what is its book value after 3 years?

A. PHP 531,250
B. PHP 300,000
C. PHP 600,000
D. PHP 550,000

17. A PHP 500,000 machine with a 5-year life is depreciated by the double declining balance method. What is the depreciation charge in year 2?

A. PHP 200,000
B. PHP 120,000
C. PHP 100,000
D. PHP 80,000

18. A fabrication shop has fixed costs of PHP 360,000 per month. Each bracket sells for PHP 450 and has a variable cost of PHP 270. How many brackets per month must be sold to break even?

A. 800 units
B. 2,000 units
C. 1,333 units
D. 1,500 units

19. A pumping station costs PHP 2,000,000 and needs PHP 80,000 per year for maintenance forever. At 8% interest, what is its capitalized cost?

A. PHP 2,080,000
B. PHP 3,000,000
C. PHP 2,640,000
D. PHP 3,250,000

20. What nominal rate compounded continuously gives an effective annual rate of 10%?

A. 10.00%
B. 10.52%
C. 9.53%
D. 9.09%

21. A simply supported beam 6 m long carries a single 12 kN load located 2 m from the left support. What is the left support reaction?

A. 8 kN
B. 4 kN
C. 6 kN
D. 12 kN

22. A 50 kg crate is pushed up a 25 degree incline at constant speed by a force parallel to the incline. If the coefficient of kinetic friction is 0.3, what force is required?

A. 340.7 N
B. 207.3 N
C. 73.9 N
D. 147.2 N

23. A projectile is launched from level ground at 30 m/s at 40 degrees above the horizontal. Neglecting air resistance, what is its horizontal range?

A. 90.3 m
B. 91.7 m
C. 59.0 m
D. 45.2 m

24. A forklift moving at 72 km/h brakes uniformly to rest in 50 m. What is the magnitude of its deceleration?

A. 8.0 m/s^2
B. 2.0 m/s^2
C. 1.4 m/s^2
D. 4.0 m/s^2

25. A rectangular section is 100 mm wide and 200 mm deep. What is its moment of inertia about the horizontal centroidal axis?

A. 66.67 x 10^6 mm^4
B. 16.67 x 10^6 mm^4
C. 266.67 x 10^6 mm^4
D. 0.67 x 10^6 mm^4

26. A spring with stiffness 2000 N/m is compressed 0.15 m and then releases a 0.5 kg block on a frictionless surface. What is the block's launch speed?

A. 9.49 m/s
B. 6.71 m/s
C. 3.00 m/s
D. 13.42 m/s

27. A 1200 kg vehicle rounds a flat curve of 60 m radius at 54 km/h. What friction force must the tires provide?

A. 2,250 N
B. 1,080 N
C. 11,772 N
D. 4,500 N

28. A 0.15 kg ball arrives at 40 m/s and leaves along the opposite direction at 30 m/s after 0.01 s of contact. What average force acted on it?

A. 150 N
B. 450 N
C. 600 N
D. 1,050 N

29. What is the pH of a 0.001 M hydrochloric acid solution used to clean a heat exchanger sample, assuming complete dissociation?

A. 11
B. 3
C. 1
D. 4

30. A freight elevator lifts a 500 kg load at a steady 2 m/s. Neglecting losses, what power is needed?

A. 9.81 kW
B. 4.91 kW
C. 1.00 kW
D. 19.62 kW

31. A flywheel with moment of inertia 4 kg m^2 is brought uniformly from rest to 300 rpm in 10 s. What constant torque is required, neglecting friction?

A. 120.00 N m
B. 2.00 N m
C. 25.13 N m
D. 12.57 N m

32. Five shaft diameters deviate from nominal by 4, 8, 6, 10 and 12 micrometers. What is the sample standard deviation?

A. 3.162 um
B. 2.828 um
C. 10.000 um
D. 4.000 um

33. What is the determinant of the 3 x 3 matrix with rows (2, 1, 3), (0, 4, -1) and (5, 2, 1)?

A. 53
B. -67
C. -53
D. 7

34. What is the limit of sin(3x)/x as x approaches 0?

A. 0
B. 1
C. 1/3
D. 3

35. A rectangular storage yard is to be fenced with 80 m of fencing on all four sides. What is the largest area it can enclose?

A. 320 m^2
B. 375 m^2
C. 400 m^2
D. 800 m^2

36. A PHP 500,000 loan for a boiler overhaul is repaid in 5 equal end-of-year payments at 10% interest. What is each payment?

A. PHP 131,898.74
B. PHP 100,000.00
C. PHP 150,000.00
D. PHP 81,898.74

37. A firm spent PHP 400,000 on a feasibility study last year. In deciding today whether to build the plant, how should that PHP 400,000 be treated?

A. Ignored as a sunk cost
B. Added to the first cost
C. Spread over the plant life
D. Treated as salvage value

38. A 100 kg motor hangs from two cables, each making 30 degrees with the horizontal, symmetric about the load. What is the tension in each cable?

A. 981 N
B. 490.5 N
C. 566.4 N
D. 1,962 N

39. A 25 m steel pipe rack beam (coefficient of expansion 12 x 10^-6 per degree C) warms by 30 degrees C. How much does it lengthen if free to expand?

A. 0.9 mm
B. 3.6 mm
C. 9.0 mm
D. 90 mm

40. What gauge pressure acts on a water intake screen 15 m below the surface of seawater (specific gravity 1.03)?

A. 147.2 kPa
B. 252.9 kPa
C. 15.4 kPa
D. 151.6 kPa

Power and Industrial Plant Engineering

41. A heat engine operates between a source at 527 degrees C and a sink at 27 degrees C. What is the maximum possible thermal efficiency?

A. 94.9%
B. 37.5%
C. 62.5%
D. 50.0%

42. A Carnot refrigerator keeps a cold room at -10 degrees C while rejecting heat to 35 degrees C surroundings. What is its COP?

A. 6.85
B. 5.85
C. 4.85
D. 0.17

43. A 0.5 m^3 receiver holds air at 800 kPa absolute and 27 degrees C. Taking R = 0.287 kJ/kg K, what mass of air does it contain?

A. 51.62 kg
B. 2.32 kg
C. 6.50 kg
D. 4.64 kg

44. What is the air-standard efficiency of an Otto cycle with a compression ratio of 8, using k = 1.4?

A. 87.5%
B. 56.5%
C. 44.8%
D. 46.4%

45. An air-standard Diesel cycle has a compression ratio of 18 and a cutoff ratio of 2 (k = 1.4). What is its thermal efficiency?

A. 68.5%
B. 63.2%
C. 55.2%
D. 49.2%

46. An ideal Brayton cycle gas turbine has a pressure ratio of 10 (k = 1.4). What is its thermal efficiency?

A. 48.2%
B. 60.2%
C. 90.0%
D. 80.7%

47. In a simple Rankine plant, steam enters the turbine at 3230 kJ/kg and leaves at 2280 kJ/kg. Condensate leaves at 192 kJ/kg and pump work is 8 kJ/kg. What is the cycle efficiency?

A. 45.5%
B. 29.4%
C. 36.1%
D. 31.1%

48. Wet steam at 100 kPa has a quality of 0.90. Taking hf = 417.5 kJ/kg and hfg = 2257.5 kJ/kg, what is its specific enthalpy?

A. 2031.8 kJ/kg
B. 2675.0 kJ/kg
C. 2407.5 kJ/kg
D. 2449.2 kJ/kg

49. A boiler produces 10,000 kg/h of steam at 2800 kJ/kg from feedwater at 420 kJ/kg while burning 900 kg/h of coal with a heating value of 30,000 kJ/kg. What is the boiler efficiency?

A. 93.1%
B. 78.1%
C. 88.1%
D. 83.6%

50. Octane (C8H18, molar mass 114.23 kg/kmol) burns completely with the theoretical amount of air (21% O2 by volume, air molar mass 28.97). What is the stoichiometric air-fuel ratio by mass?

A. 3.5
B. 12.1
C. 15.1
D. 18.1

51. Ten kilograms of water (c = 4.187 kJ/kg K) are heated from 20 degrees C to 80 degrees C at constant pressure. What is the entropy change of the water?

A. 58.04 kJ/K
B. 7.11 kJ/K
C. 7.80 kJ/K
D. 8.57 kJ/K

52. A run-of-river hydro unit has a net head of 80 m, a flow of 5 m^3/s and an overall efficiency of 88%. What electrical output does it deliver?

A. 3,924 kW
B. 3,453 kW
C. 4,459 kW
D. 352 kW

53. A centrifugal pump delivers 0.05 m^3/s of water against a total head of 40 m with an efficiency of 75%. What shaft power does it need?

A. 19.62 kW
B. 14.71 kW
C. 2.67 kW
D. 26.16 kW

54. A pump draws 30 kW at 1750 rpm. If its speed is reduced to 1450 rpm with the same impeller and system, what power is expected?

A. 24.86 kW
B. 20.60 kW
C. 17.07 kW
D. 52.74 kW

55. A boiler feed pump begins to make crackling noises and its head drops after the suction tank level was lowered. Which condition most likely explains this?

A. Discharge valve opened too slowly
B. NPSH available fell below NPSH required
C. Motor speed rose above rated speed
D. Fluid viscosity increased sharply

56. An air compressor takes in 0.1 m^3/s of free air at 100 kPa and compresses it isothermally to 700 kPa. What is the ideal power required?

A. 60.00 kW
B. 8.45 kW
C. 26.03 kW
D. 19.46 kW

57. A reciprocating compressor has 5% clearance and a pressure ratio of 8, with polytropic exponent n = 1.3. What is its volumetric efficiency?

A. 95.0%
B. 80.2%
C. 65.0%
D. 85.9%

58. A two-stage air compressor with perfect intercooling takes air at 100 kPa and discharges at 900 kPa. What intermediate pressure minimizes total work?

A. 500 kPa
B. 450 kPa
C. 300 kPa
D. 400 kPa

59. A furnace brick wall is 0.2 m thick with k = 0.7 W/m K and an area of 10 m^2. If its faces differ by 30 degrees C, what is the steady heat flow?

A. 42 W
B. 105 W
C. 1,050 W
D. 4,200 W

60. A 1 m^2 composite wall has 0.1 m of insulation (k = 0.05 W/m K) on 0.2 m of concrete (k = 1.0 W/m K). With a 100 degree C overall temperature difference, what is the heat flow?

A. 500.0 W
B. 50.0 W
C. 45.5 W
D. 33.3 W

61. A 1 m^2 steam pipe surface (emissivity 0.8) at 500 K radiates to large surroundings at 300 K. What is the net radiant heat loss?

A. 73 W
B. 3,084 W
C. 2,835 W
D. 2,468 W

62. Air at 30 degrees C flows over a 2 m^2 plate held at 80 degrees C. With a convection coefficient of 25 W/m^2 K, what is the heat transfer rate?

A. 2,500 W
B. 1,250 W
C. 4,000 W
D. 5,500 W

63. In a counterflow heat exchanger, oil cools from 150 to 90 degrees C while water warms from 30 to 70 degrees C. What is the log mean temperature difference?

A. 55.8 degrees C
B. 70.0 degrees C
C. 69.5 degrees C
D. 60.0 degrees C

64. A vapor-compression system has enthalpies of 395 kJ/kg at evaporator exit, 430 kJ/kg at compressor exit and 245 kJ/kg at condenser exit. What is the refrigeration COP?

A. 5.29
B. 4.29
C. 0.23
D. 0.81

65. Room air is at 30 degrees C and 60% relative humidity at 101.325 kPa. If the saturation pressure at 30 degrees C is 4.246 kPa, what is the humidity ratio?

A. 0.0160 kg/kg dry air
B. 0.0272 kg/kg dry air
C. 0.0156 kg/kg dry air
D. 0.0251 kg/kg dry air

66. A cooling coil cools 2 kg/s of air from 32 to 18 degrees C with no condensation (cp = 1.005 kJ/kg K). What sensible cooling load does it carry?

A. 28.14 kW
B. 14.07 kW
C. 64.32 kW
D. 117.24 kW

67. A cooling tower receives water at 40 degrees C and returns it at 30 degrees C. The ambient wet-bulb temperature is 26 degrees C. What is the approach?

A. 10 degrees C
B. 14 degrees C
C. 4 degrees C
D. 6 degrees C

68. A 60 m chimney carries flue gas of density 0.75 kg/m^3 while the outside air is 1.18 kg/m^3. What theoretical natural draft does it produce?

A. 441.5 Pa
B. 25.8 Pa
C. 694.5 Pa
D. 253.1 Pa

69. Geothermal brine with h = 1100 kJ/kg is throttled into a separator where hf = 670 kJ/kg and hfg = 2086 kJ/kg. What fraction of the brine flashes to steam?

A. 0.321
B. 0.527
C. 0.206
D. 0.156

70. A dynamometer shows a diesel engine delivering 250 N m of torque at 3000 rpm. What is its brake power?

A. 78.54 kW
B. 750.00 kW
C. 39.27 kW
D. 12.50 kW

71. A four-stroke, 4-cylinder engine has a 100 mm bore and 120 mm stroke, runs at 2400 rpm, and has an indicated mean effective pressure of 900 kPa. What is its indicated power?

A. 67.86 kW
B. 135.72 kW
C. 16.96 kW
D. 50.89 kW

72. A generator set delivers 60 kW of brake power while burning 15 kg/h of diesel with a heating value of 43,000 kJ/kg. What is its brake thermal efficiency?

A. 32.0%
B. 40.2%
C. 25.1%
D. 33.5%

73. An engine uses 18 kg of fuel per hour while producing 75 kW of brake power. What is its brake specific fuel consumption?

A. 4.167 kg/kWh
B. 0.300 kg/kWh
C. 0.240 kg/kWh
D. 0.180 kg/kWh

74. Steam expands in a nozzle with an isentropic enthalpy drop of 120 kJ/kg. Neglecting inlet velocity and losses, what is the exit velocity?

A. 15.5 m/s
B. 346.4 m/s
C. 692.8 m/s
D. 489.9 m/s

75. Adding a regenerator to a simple gas turbine improves efficiency most under which condition?

A. High pressure ratio, cool exhaust
B. Low pressure ratio, hot turbine exhaust
C. Very low turbine inlet temperature
D. Compressor exit hotter than exhaust

76. In a steam plant, which component's main purpose is to remove dissolved oxygen and carbon dioxide from feedwater?

A. Deaerator
B. Economizer
C. Superheater
D. Desuperheater

77. A boiler component placed in the flue gas path uses leftover heat to warm feedwater before it enters the drum. What is it called?

A. Economizer
B. Air preheater
C. Reheater
D. Steam separator

78. A 25 MW diesel power plant has a peak demand of 20 MW and an average load of 12 MW. What is its capacity factor?

A. 60%
B. 80%
C. 48%
D. 40%

79. Water flows at 2 m/s in a 150 mm pipe that reduces to 75 mm diameter. What is the velocity in the smaller pipe?

A. 4 m/s
B. 8 m/s
C. 1 m/s
D. 16 m/s

80. Water flows at 2 m/s through 200 m of 100 mm pipe with a Darcy friction factor of 0.02. What is the head loss due to friction?

A. 4.08 m
B. 0.82 m
C. 16.31 m
D. 8.15 m

Machine Design, Materials and Shop Practice

81. A line shaft transmits 50 kW at 600 rpm. What torque does it carry?

A. 795.8 N m
B. 83.3 N m
C. 1591.5 N m
D. 13.3 N m

82. A solid shaft must transmit 800 N m of torque with an allowable shear stress of 40 MPa. What minimum diameter is required?

A. 58.8 mm
B. 28.0 mm
C. 46.7 mm
D. 37.4 mm

83. A 40 mm solid steel shaft 1.5 m long carries 500 N m of torque. With G = 80 GPa, what is the angle of twist?

A. 0.04 degrees
B. 1.07 degrees
C. 4.27 degrees
D. 2.14 degrees

84. A 25 mm diameter tie rod carries an axial tensile load of 60 kN. What is the normal stress in the rod?

A. 30.6 MPa
B. 96.0 MPa
C. 244.5 MPa
D. 122.2 MPa

85. A 2 m steel rod of 20 mm diameter is pulled by 40 kN. With E = 200 GPa, how much does it elongate?

A. 0.318 mm
B. 1.273 mm
C. 12.732 mm
D. 0.637 mm

86. A simply supported 4 m beam carries a uniform load of 10 kN/m and has a 100 mm wide by 200 mm deep rectangular section. What is the maximum bending stress?

A. 30.0 MPa
B. 15.0 MPa
C. 60.0 MPa
D. 120.0 MPa

87. A cantilever 1.5 m long carries a 2 kN load at its free end. With E = 200 GPa and I = 8 x 10^6 mm^4, what is the tip deflection?

A. 0.527 mm
B. 4.219 mm
C. 0.703 mm
D. 1.406 mm

88. A 3 m steel strut, pinned at both ends, has E = 200 GPa and minimum I = 2 x 10^6 mm^4. What is its Euler critical load?

A. 109.7 kN
B. 1754.6 kN
C. 438.6 kN
D. 877.3 kN

89. A cylindrical air receiver of 1.2 m inside diameter and 12 mm wall thickness holds 1.5 MPa. What is the hoop stress using thin-wall theory?

A. 37.5 MPa
B. 75.0 MPa
C. 150.0 MPa
D. 18.8 MPa

90. A bracket is held by four 16 mm bolts in single shear that share a 80 kN load equally. What is the average shear stress per bolt?

A. 99.5 MPa
B. 397.9 MPa
C. 49.7 MPa
D. 24.9 MPa

91. A 12 mm square key, 60 mm long, fixes a hub to a 50 mm shaft transmitting 600 N m. What is the shear stress in the key?

A. 66.7 MPa
B. 33.3 MPa
C. 16.7 MPa
D. 40.0 MPa

92. A helical compression spring has wire diameter 6 mm, mean coil diameter 48 mm, 10 active coils and G = 80 GPa. What is its spring rate?

A. 11.72 N/mm
B. 23.44 N/mm
C. 93.75 N/mm
D. 5.86 N/mm

93. Two springs of 20 N/mm and 30 N/mm are connected end to end (in series). What is the equivalent spring rate?

A. 50 N/mm
B. 12 N/mm
C. 25 N/mm
D. 10 N/mm

94. A flat belt runs at 12 m/s with tight-side tension 1500 N and slack-side tension 600 N. What power does it transmit?

A. 25.2 kW
B. 10.8 kW
C. 18.0 kW
D. 7.2 kW

95. A flat belt has a coefficient of friction of 0.3 and wraps 165 degrees around the smaller pulley. What is the maximum ratio of tight-side to slack-side tension?

A. 1.64
B. 2.57
C. 1.86
D. 2.37

96. A spur gear pair uses module 5 mm with a 20-tooth pinion and a 50-tooth gear. What is the standard center distance?

A. 350 mm
B. 175 mm
C. 150 mm
D. 125 mm

97. In a compound gear train, gear A (20 teeth) drives B (60 teeth); C (15 teeth) on B's shaft drives D (45 teeth). If A turns at 1800 rpm, how fast does D turn?

A. 600 rpm
B. 450 rpm
C. 150 rpm
D. 200 rpm

98. A spur pinion of 150 mm pitch diameter transmits 15 kW at 1000 rpm. What is the tangential force on its teeth?

A. 6,000 N
B. 3,820 N
C. 1,910 N
D. 955 N

99. A ball bearing has a basic dynamic load rating of 30 kN and carries an equivalent load of 5 kN at 1500 rpm. What is its rated L10 life in hours?

A. 4,361 h
B. 2,400 h
C. 67 h
D. 400 h

100. In the standard bearing life equation L = (C/P)^p, what exponent p applies to roller bearings?

A. 10/3
B. 3
C. 2
D. 3/10

101. A fillet weld with an 8 mm leg and 150 mm length has an allowable shear stress of 95 MPa on its throat. What load can it carry?

A. 114.0 kN
B. 40.3 kN
C. 80.6 kN
D. 57.0 kN

102. A punch press flywheel must absorb a 5000 J energy fluctuation at a mean speed of 300 rpm with a coefficient of speed fluctuation of 0.04. What moment of inertia is needed?

A. 63.3 kg m^2
B. 1.4 kg m^2
C. 253.3 kg m^2
D. 126.7 kg m^2

103. A single-plate clutch with two friction surfaces has inner and outer radii of 60 mm and 100 mm, mu = 0.3 and an axial force of 4 kN. Assuming uniform wear, what torque can it transmit?

A. 96 N m
B. 240 N m
C. 192 N m
D. 384 N m

104. A double-threaded power screw has a pitch of 6 mm. How far does the nut advance per revolution?

A. 6 mm
B. 3 mm
C. 18 mm
D. 12 mm

105. A machine link made of steel with an ultimate strength of 450 MPa operates at a working stress of 150 MPa. What is its factor of safety based on ultimate strength?

A. 0.33
B. 2.0
C. 3.0
D. 4.5

106. On the iron-carbon equilibrium diagram, at about what carbon content does the eutectoid reaction (austenite to pearlite) occur?

A. About 0.02% C
B. About 2.11% C
C. About 4.3% C
D. About 0.77% C

107. A medium-carbon steel gear is heated into the austenite range and then quenched rapidly in water. What hard, brittle phase forms?

A. Coarse pearlite
B. Martensite
C. Ferrite
D. Spheroidite

108. A cold-worked steel part is too hard to machine. Which heat treatment best softens it and relieves internal stress?

A. Water quenching
B. Induction hardening
C. Nitriding
D. Full annealing

109. A newly hardened tool steel punch is too brittle for service. What follow-up treatment improves toughness?

A. Carburizing
B. Tempering
C. Normalizing
D. Cold working

110. A low-carbon steel cam needs a hard, wear-resistant surface with a tough core. Which process adds carbon to the surface before hardening?

A. Tempering
B. Annealing
C. Carburizing
D. Stress relieving

111. In the Rockwell C hardness test, what type of indenter is used?

A. Hardened steel ball
B. Square-based pyramid
C. Diamond cone
D. Tungsten carbide wedge

112. A foundry treats molten cast iron with magnesium so that graphite forms as spheres, giving good ductility. What material results?

A. Gray cast iron
B. Ductile (nodular) iron
C. White cast iron
D. Malleable iron

113. Which alloying element is chiefly responsible for the corrosion resistance of stainless steels?

A. Chromium
B. Manganese
C. Silicon
D. Tungsten

114. A valve body is specified as brass. What are the two principal metals in this alloy?

A. Copper and tin
B. Iron and nickel
C. Aluminum and copper
D. Copper and zinc

115. An 80 mm diameter bar is turned on a lathe at a recommended cutting speed of 30 m/min. What spindle speed should be set?

A. 375 rpm
B. 239 rpm
C. 119 rpm
D. 188 rpm

116. A 300 mm long shaft is turned in one pass at 0.25 mm/rev feed and 400 rpm. Neglecting approach, how long does the cut take?

A. 3.0 min
B. 1.2 min
C. 7.5 min
D. 0.3 min

117. A cutting tool follows Taylor's equation V T^0.25 = 300 (V in m/min, T in min). What tool life is expected at a cutting speed of 150 m/min?

A. 2 min
B. 16 min
C. 4 min
D. 8 min

118. A shop must cut teeth on spur gears using a rotating multi-tooth cutter that turns in timed relation with the gear blank. Which process is this?

A. Gear broaching
B. Gear hobbing
C. Gear shaving
D. Gear lapping

119. In the AWS designation E7018 for a shielded metal arc electrode, what does the 70 indicate?

A. 70 ksi minimum tensile strength
B. 70 percent iron powder content
C. 7.0 mm electrode diameter
D. Usable in 70 degree positions

120. For a wrought steel with an ultimate strength of 600 MPa, what is a common first estimate of its rotating-beam endurance limit?

A. About 300 MPa
B. About 600 MPa
C. About 150 MPa
D. About 450 MPa

Answer key

Mechanical Engineering

1. B. x = 3 and x = 0.5

Factoring gives (2x - 1)(x - 3) = 0, so x = 0.5 and x = 3.

2. B. 1

ds/dx = 3x^2 - 8x + 5 = 12 - 16 + 5 = 1 at x = 2.

3. D. 18

Antiderivative x^3/3 + x^2 gives 9 + 9 = 18 at x = 3, and 0 at x = 0.

4. B. 26.83 cm^2

Heron's formula: s = 12, area = sqrt(12 x 5 x 4 x 3) = sqrt(720) = 26.83 cm^2.

5. C. 5/36

Favorable outcomes are (2,6), (3,5), (4,4), (5,3), (6,2): 5 of 36.

6. C. 126

Order does not matter, so C(9,4) = 9!/(4! 5!) = 126.

7. A. 3.561

x = ln 50 / ln 3 = 3.912/1.099 = 3.561.

8. A. 1.2 units

d = |4(3) + 3(-2) - 12| / sqrt(16 + 9) = 6/5 = 1.2.

9. D. 860

Arithmetic series with a = 5, d = 4: S = (20/2)(2(5) + 19(4)) = 10(86) = 860.

10. C. 6

Completing squares: (x - 3)^2 + (y + 4)^2 = 11 + 9 + 16 = 36, so r = 6.

11. D. 11.18

|z1 z2| = |z1||z2| = 5 x sqrt(5) = 11.18.

12. C. 18.39

y = 50 e^(-0.2t); at t = 5, y = 50 e^(-1) = 18.39.

13. B. PHP 148,594.74

i = 0.08/4 = 0.02 per quarter for 20 periods: F = 100,000(1.02)^20 = PHP 148,594.74.

14. B. 12.68%

ER = (1 + 0.12/12)^12 - 1 = 12.68%.

15. A. PHP 160,441.44

P = A[1 - (1.09)^-10]/0.09 = 25,000 x 6.4177 = PHP 160,441.44.

16. D. PHP 550,000

Annual depreciation = (850,000 - 50,000)/8 = 100,000; book value = 850,000 - 300,000 = 550,000.

17. B. PHP 120,000

Rate = 2/5 = 40%. Year 1: 200,000; book value 300,000; year 2: 0.40 x 300,000 = 120,000.

18. B. 2,000 units

Break-even = 360,000/(450 - 270) = 360,000/180 = 2,000 units.

19. B. PHP 3,000,000

Capitalized cost = 2,000,000 + 80,000/0.08 = 2,000,000 + 1,000,000 = PHP 3,000,000.

20. C. 9.53%

r = ln(1.10) = 9.53%.

21. A. 8 kN

Summing moments about the right support: R_L(6) = 12(4), so R_L = 8 kN.

22. A. 340.7 N

F = mg(sin 25 + 0.3 cos 25) = 490.5(0.4226 + 0.2719) = 340.7 N.

23. A. 90.3 m

R = v^2 sin(2 theta)/g = 900 sin 80 / 9.81 = 90.3 m.

24. D. 4.0 m/s^2

72 km/h = 20 m/s; a = v^2/(2s) = 400/100 = 4.0 m/s^2.

25. A. 66.67 x 10^6 mm^4

I = bh^3/12 = 100(200)^3/12 = 66.67 x 10^6 mm^4.

26. A. 9.49 m/s

(1/2)kx^2 = (1/2)mv^2, so v = 0.15 sqrt(2000/0.5) = 9.49 m/s.

27. D. 4,500 N

v = 15 m/s; F = mv^2/r = 1200(225)/60 = 4,500 N.

28. D. 1,050 N

Impulse = m(change in v) = 0.15(40 + 30) = 10.5 N s; F = 10.5/0.01 = 1,050 N.

29. B. 3

[H+] = 10^-3 M, so pH = -log(10^-3) = 3.

30. A. 9.81 kW

P = mgv = 500(9.81)(2) = 9,810 W = 9.81 kW.

31. D. 12.57 N m

omega = 31.42 rad/s; alpha = 3.142 rad/s^2; T = I alpha = 4(3.142) = 12.57 N m.

32. A. 3.162 um

Mean = 8; sum of squared deviations = 40; s = sqrt(40/4) = 3.162 um.

33. C. -53

Expanding along row 1: 2(4 + 2) - 1(0 + 5) + 3(0 - 20) = 12 - 5 - 60 = -53.

34. D. 3

sin(3x)/x = 3 sin(3x)/(3x), and sin(u)/u approaches 1, so the limit is 3.

35. C. 400 m^2

Area is maximized by a square of side 20 m, giving 400 m^2.

36. A. PHP 131,898.74

A = P i/[1 - (1 + i)^-n] = 500,000(0.1)/(1 - 1.1^-5) = PHP 131,898.74.

37. A. Ignored as a sunk cost

Money already spent and unrecoverable does not differ between alternatives, so it is excluded from the decision.

38. A. 981 N

2T sin 30 = 981 N, so T = 981 N.

39. C. 9.0 mm

Change in L = alpha L dT = 12e-6(25,000 mm)(30) = 9.0 mm.

40. D. 151.6 kPa

p = rho g h = 1030(9.81)(15) = 151.6 kPa gauge.

41. C. 62.5%

Carnot efficiency = 1 - 300/800 = 0.625, using absolute temperatures.

42. B. 5.85

COP = T_L/(T_H - T_L) = 263.15/45 = 5.85.

43. D. 4.64 kg

m = PV/RT = 800(0.5)/(0.287 x 300.15) = 4.64 kg.

44. B. 56.5%

eta = 1 - 1/r^(k-1) = 1 - 8^-0.4 = 56.5%.

45. B. 63.2%

eta = 1 - (1/18^0.4)(2^1.4 - 1)/(1.4 x 1) = 63.2%.

46. A. 48.2%

eta = 1 - rp^(-(k-1)/k) = 1 - 10^-0.2857 = 48.2%.

47. D. 31.1%

q_in = 3230 - 200 = 3030 kJ/kg; w_net = 950 - 8 = 942 kJ/kg; eta = 942/3030 = 31.1%.

48. D. 2449.2 kJ/kg

h = hf + x hfg = 417.5 + 0.9(2257.5) = 2449.2 kJ/kg.

49. C. 88.1%

eta = 10,000(2800 - 420)/(900 x 30,000) = 23.8e6/27.0e6 = 88.1%.

50. C. 15.1

12.5 kmol O2 needs 12.5 x 4.76 = 59.5 kmol air = 1723.7 kg; A/F = 1723.7/114.23 = 15.1.

51. C. 7.80 kJ/K

dS = mc ln(T2/T1) = 41.87 ln(353.15/293.15) = 7.80 kJ/K.

52. B. 3,453 kW

P = rho g Q H eta = 9.81(5)(80)(0.88) = 3,453 kW.

53. D. 26.16 kW

P = rho g Q H/eta = 9.81(0.05)(40)/0.75 = 26.16 kW.

54. C. 17.07 kW

Affinity law: P2 = P1(N2/N1)^3 = 30(0.8286)^3 = 17.07 kW.

55. B. NPSH available fell below NPSH required

Lower suction level reduces NPSH available; when it drops below NPSH required, vapor bubbles form and collapse (cavitation).

56. D. 19.46 kW

W = P1 V1 ln(P2/P1) = 100(0.1) ln 7 = 19.46 kW.

57. B. 80.2%

eta_v = 1 + c - c(rp)^(1/n) = 1.05 - 0.05(8)^0.769 = 80.2%.

58. C. 300 kPa

Optimum p_i = sqrt(p1 p2) = sqrt(100 x 900) = 300 kPa.

59. C. 1,050 W

Q = kA dT/L = 0.7(10)(30)/0.2 = 1,050 W.

60. C. 45.5 W

R = 0.1/0.05 + 0.2/1.0 = 2.2 K/W; Q = 100/2.2 = 45.5 W.

61. D. 2,468 W

Q = e sigma A (Ts^4 - Tsur^4) = 0.8(5.67e-8)(6.25e10 - 0.81e10) = 2,468 W.

62. A. 2,500 W

Q = hA(Ts - T_inf) = 25(2)(50) = 2,500 W.

63. C. 69.5 degrees C

dT1 = 150 - 70 = 80, dT2 = 90 - 30 = 60; LMTD = 20/ln(80/60) = 69.5 degrees C.

64. B. 4.29

Refrigerating effect = 395 - 245 = 150 kJ/kg; work = 430 - 395 = 35 kJ/kg; COP = 150/35 = 4.29.

65. A. 0.0160 kg/kg dry air

pv = 0.6(4.246) = 2.548 kPa; W = 0.622(2.548)/(101.325 - 2.548) = 0.0160.

66. A. 28.14 kW

Q = m cp dT = 2(1.005)(14) = 28.14 kW.

67. C. 4 degrees C

Approach = cold water temperature - wet-bulb = 30 - 26 = 4 degrees C (the range is 10).

68. D. 253.1 Pa

Draft = H g (rho_air - rho_gas) = 60(9.81)(0.43) = 253.1 Pa.

69. C. 0.206

Throttling is isenthalpic: x = (1100 - 670)/2086 = 0.206.

70. A. 78.54 kW

P = 2 pi N T = 2 pi (50 rev/s)(250) = 78.54 kW.

71. A. 67.86 kW

Vd = (pi/4)(0.1)^2(0.12) = 9.425e-4 m^3; P = 900(9.425e-4)(4)(2400/120) = 67.86 kW (one power stroke per 2 revolutions).

72. D. 33.5%

Fuel energy = 15(43,000)/3600 = 179.2 kW; eta = 60/179.2 = 33.5%.

73. C. 0.240 kg/kWh

bsfc = 18/75 = 0.240 kg/kWh.

74. D. 489.9 m/s

V = sqrt(2 dh) = sqrt(2 x 120,000) = 489.9 m/s; enthalpy must be in J/kg.

75. B. Low pressure ratio, hot turbine exhaust

A regenerator needs turbine exhaust hotter than compressor discharge; this gap is largest at low pressure ratios.

76. A. Deaerator

A deaerator heats feedwater with steam to drive off dissolved gases that would corrode boiler surfaces.

77. A. Economizer

The economizer recovers flue gas heat into feedwater; an air preheater instead heats combustion air.

78. C. 48%

Capacity factor = average load/installed capacity = 12/25 = 48% (load factor would be 12/20 = 60%).

79. B. 8 m/s

Continuity: V2 = V1(D1/D2)^2 = 2(2)^2 = 8 m/s.

80. D. 8.15 m

hf = f(L/D)(V^2/2g) = 0.02(2000)(4/19.62) = 8.15 m.

81. A. 795.8 N m

T = P/omega = 50,000/(2 pi x 10 rev/s) = 795.8 N m.

82. C. 46.7 mm

d = (16T/(pi tau))^(1/3) = (16 x 800,000/(pi x 40))^(1/3) = 46.7 mm.

83. D. 2.14 degrees

J = pi d^4/32 = 251,327 mm^4; theta = TL/(GJ) = 0.0373 rad = 2.14 degrees.

84. D. 122.2 MPa

sigma = P/A = 60,000/(pi(25)^2/4) = 60,000/490.9 = 122.2 MPa.

85. B. 1.273 mm

delta = PL/(AE) = 40,000(2000)/(314.16 x 200,000) = 1.273 mm.

86. A. 30.0 MPa

M = wL^2/8 = 20 kN m; S = bh^2/6 = 666,667 mm^3; sigma = 20e6/666,667 = 30.0 MPa.

87. D. 1.406 mm

delta = PL^3/(3EI) = 2000(1500^3)/(3 x 200,000 x 8e6) = 1.406 mm.

88. C. 438.6 kN

Pcr = pi^2 EI/L^2 = pi^2(200,000)(2e6)/3000^2 = 438.6 kN.

89. B. 75.0 MPa

sigma_h = pD/(2t) = 1.5(1200)/(2 x 12) = 75.0 MPa; longitudinal stress is half of this.

90. A. 99.5 MPa

Each bolt takes 20 kN; tau = 20,000/(pi(16)^2/4) = 99.5 MPa.

91. B. 33.3 MPa

F = 2T/d = 2(600,000)/50 = 24,000 N; tau = F/(bL) = 24,000/(12 x 60) = 33.3 MPa.

92. A. 11.72 N/mm

k = Gd^4/(8D^3 n) = 80,000(1296)/(8 x 110,592 x 10) = 11.72 N/mm.

93. B. 12 N/mm

1/k = 1/20 + 1/30 = 1/12, so k = 12 N/mm.

94. B. 10.8 kW

P = (T1 - T2)v = 900(12) = 10,800 W = 10.8 kW.

95. D. 2.37

T1/T2 = e^(mu theta) = e^(0.3 x 2.880) = 2.37.

96. B. 175 mm

Pitch diameters are 100 mm and 250 mm; center distance = (100 + 250)/2 = 175 mm.

97. D. 200 rpm

Train value = (20/60)(15/45) = 1/9; 1800/9 = 200 rpm.

98. C. 1,910 N

V = pi(0.15)(1000/60) = 7.854 m/s; Ft = 15,000/7.854 = 1,910 N.

99. B. 2,400 h

L10 = (C/P)^3 = 216 million revolutions; hours = 216e6/(1500 x 60) = 2,400 h.

100. A. 10/3

The exponent is 3 for ball bearings and 10/3 for roller bearings.

101. C. 80.6 kN

Throat = 0.707(8) = 5.66 mm; F = 5.66(150)(95) = 80.6 kN.

102. D. 126.7 kg m^2

dE = I omega^2 Cs, so I = 5000/(31.42^2 x 0.04) = 126.7 kg m^2.

103. C. 192 N m

Mean radius = 80 mm; T = n mu F r_m = 2(0.3)(4000)(0.08) = 192 N m.

104. D. 12 mm

Lead = number of starts x pitch = 2 x 6 = 12 mm.

105. C. 3.0

FS = ultimate strength/working stress = 450/150 = 3.0.

106. D. About 0.77% C

The eutectoid point is near 0.77% C; 2.11% is maximum solubility in austenite and 4.3% is the eutectic.

107. B. Martensite

Rapid cooling suppresses diffusion, trapping carbon in a body-centered tetragonal structure called martensite.

108. D. Full annealing

Annealing heats the steel and cools it slowly in the furnace, producing a soft, stress-relieved structure.

109. B. Tempering

Tempering reheats martensite below the lower critical temperature to trade some hardness for toughness.

110. C. Carburizing

Carburizing diffuses carbon into the surface of low-carbon steel, which is then quenched to form a hard case.

111. C. Diamond cone

Rockwell C uses a 120 degree diamond cone (Brale); Rockwell B uses a steel ball.

112. B. Ductile (nodular) iron

Magnesium or cerium treatment produces spheroidal graphite, the defining feature of ductile iron.

113. A. Chromium

Chromium forms a thin, self-healing chromium oxide film that passivates the surface.

114. D. Copper and zinc

Brass is a copper-zinc alloy; bronze is traditionally copper-tin.

115. C. 119 rpm

N = 1000V/(pi D) = 1000(30)/(pi x 80) = 119 rpm.

116. A. 3.0 min

Feed rate = 0.25(400) = 100 mm/min; time = 300/100 = 3.0 min.

117. B. 16 min

T = (300/150)^(1/0.25) = 2^4 = 16 min.

118. B. Gear hobbing

Hobbing generates teeth continuously with a rotating hob synchronized with the blank.

119. A. 70 ksi minimum tensile strength

The first two digits give minimum weld metal tensile strength in thousands of psi (70 ksi, about 480 MPa).

120. A. About 300 MPa

For steels with ultimate strength up to about 1400 MPa, the endurance limit is often estimated as 0.5 Su.

Topics to review

• Statics, dynamics and machine design

• Thermodynamics and power cycles

• Fluid mechanics, pumps and heat transfer

• Refrigeration and industrial plant maintenance

Online question banks and study resources

Mechanical engineer - Pass Harbor (Question bank)

Certified plant mechanic - Pass Harbor (Question bank)

Official PRC board information

Current PRC exam programs

Independent study material prepared by Board Exam Desk.