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Question Booklet No.

QUESTION BOOKLET

MECHANICAL ENGINEERING

Booklet Series

A

Roll No. | | | | | |

(Enter your Roll number in the above space)

Time Allowed : 2 Hours **Maximum Marks : 100**

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1. The maximum energy that can be absorbed up to the elastic limit, without creating a permanent distortion is called

[A] proof resilience

[B] modulus of resilience

[C] toughness

[D] flexural rigidity

2. A box is resting on a floor with coefficient of friction equal to 0·4. At what maximum height H, the box be pulled if it is to move with uniform velocity without overturning?

[A] H = 30 mm

[B] H = 60 mm

[C] H = 75 mm

[D] H = 150 mm

3. In a plate clutch, the axial force is 5 kN. The inside diameter of the contact surface is 150 mm and the outside diameter is 300 mm. For uniform pressure, the mean radius of the friction surface will be

[A] 116·7 mm

[B] 233·3 mm

[C] 112·5 mm

[D] 225 mm

4. 2·5 kW of power is transmitted by an open-belt drive. The linear velocity of the belt is 2·5 m/s. The angle of lap is such maintained that the ratio of tension on the tight and slack side is 3. What will be the initial tension in the belt? [Without considering centrifugal tension]

[A] 500 N

[B] 800 N

[C] 1000 N

[D] 1200 N

5. To make a bolt of uniform strength, a hole is drilled in the shank part. If the nominal diameter of the bolt is 12 mm and the core diameter is 0·80 times the nominal diameter, then radius of the hole is

[A] 3·2 mm

[B] 2·8 mm

[C] 2·4 mm

[D] 3·6 mm

6. In a single degree of freedom under damped spring-mass-damper system as shown in the figure, an additional damper is added in parallel such that the system remains under-damped. Which one of the following statements is always ***true***?

[A] Transmissibility will increase

[B] Transmissibility will decrease

[C] Time period of free oscillations will increase

[D] Time period of free oscillations will decrease

7. A gear tooth profile generated using a curve traced by a point on the circumference of a circle that rolls without slipping on a fixed straight line, is known as

[A] epi-cycloid

[B] hypo-cycloid

[C] involute

[D] cycloid

8. A pipeline 20 cm in diameter, 70 m long conveys oil of specific gravity 0·95 and viscosity 0·23 Ns/m^2. If the velocity of oil is 1·38 m/s, find the difference in pressure heads between the two ends of the pipe.

[A] 2·52 m

[B] 3·75 m

[C] 1·21 m

[D] 1·91 m

9. When the fluid pipes are connected in parallel, the total loss of head is

[A] equal to the sum of the loss of head in each pipe

[B] same as in each pipe

[C] equal to the reciprocal of the sum of loss of head in each pipe

[D] None of the above

10. It is required to find the pressure difference between two horizontal pipes through which water is flowing using an inverted manometer. Two manometric fluids with specific gravities 13·6 and 0·8 are available. Which manometric fluid is to be used?

[A] Fluid with specific gravity 13·6

[B] Fluid with specific gravity 0·8

[C] Both fluids can be used

[D] None can be used

11. Due to aging of a pipeline, its carrying capacity has decreased by 25%. The corresponding increase in the Darcy-Weisbach friction factor f is

[A] 63%

[B] 77%

[C] 56%

[D] 86%

12. A reversible engine is operating with temperature limits of 800 K and 300 K. If it takes 560 kJ of heat, then unavailable work should be

[A] 210 kJ

[B] 200 kJ

[C] 175 kJ

[D] 150 kJ

13. The volume V versus temperature T graphs for a certain amount of a perfect gas at two pressures P_1 and P_2 are as shown in the figure. It can be concluded that

[A] the pressure P_1 is greater than the pressure P_2

[B] the adiabatic index for P_1 is higher than that for P_2

[C] P_1 represents monoatomic gas and P_2 represents diatomic gas

[D] P_2 represents monoatomic gas and P_1 represents diatomic gas

14. 85 kJ of heat is supplied to a closed system at constant volume. During the next process, the system rejects 90 kJ of heat at constant pressure while 20 kJ of work is done on it. The system is brought to the original state by adiabatic process. The initial internal energy is 100 kJ. What is the quantity of work transfer during the process?

[A] 30 kJ

[B] 20 kJ

[C] 10 kJ

[D] 15 kJ

15. In a vapour absorption refrigerator, the temperatures of evaporator and ambient are 10 °C and 30 °C respectively. If the COP of the system is 2, estimate the generator temperature.

[A] 90 °C

[B] 85 °C

[C] 80 °C

[D] 75 °C

16. In a CNC machine tool, the function of an interpolator is to generate

[A] reference signal prescribing the shape of the part to be machined

[B] error signal for tool radius compensation during machining

[C] NC code from the part drawing during post-processing

[D] signal for the lubrication pump during machining

17. **Assertion (A)** : Die-casting yields a product of good accuracy and finish.

Reason (R) : Low melting alloys are used in die-casting.

[A] Both A and R are individually true and R is the correct explanation of A

[B] Both A and R are individually true and R is not the correct explanation of A

[C] A is true but R is false

[D] A is false but R is true

18. Which one of the following is the correct statement pertaining to the friction welding process?

[A] Heat affected zone is not formed

[B] Flashes are not produced

[C] Dissimilar materials cannot be joined

[D] Melting of the base material(s) is not involved

19. Which one of the following statements related to grinding process is ***incorrect***?

[A] Grinding wheels made of finer abrasive grains produce better surface finish

[B] Abrasive grains tend to fracture frequently during the grinding process

[C] Specific energy in grinding is higher than that in turning

[D] Cutting speed in grinding process is much lower than that in face milling

20. The size of abrasive grains in an abrasive jet machining ranges from

[A] 1 to 10 microns

[B] 10 to 50 microns

[C] 50 to 100 microns

[D] 100 to 500 microns

21. The solidification time for a cuboidal block ($20 \times 15 \times 10$ cm^3) is 20 seconds. The solidification time for a sphere of same volume will be

[A] 20 sec

[B] 33·3 sec

[C] 35·1 sec

[D] 21·2 sec

22. The cutting tool signature as per ASA is 6° – 11° – 10° – 7° – 10° – 30° – 0·5 inch. The difference in side cutting edge angle and end cutting edge angle is

[A] 23°

[B] 19°

[C] 20°

[D] 24°

23. In orthogonal cutting of a mild-steel component, if rake angle of tool is 10° and shear angle is 30°, find the chip reduction coefficient.

[A] 0·55

[B] 0·66

[C] 0·9

[D] 0·7

24. The DC power source for arc welding has the characteristics as $4V + 2I = 240$, where V = voltage and I = current in amperes. The maximum arc power at the electrode is

[A] 5·2 kW

[B] 1·7 kW

[C] 2 kW

[D] 1·8 kW

25. The amount of time by which an activity can be delayed without affecting project completion time is

[A] free float

[B] total float

[C] independent float

[D] activity float

26. An organization has decided to produce a new product. Fixed cost for producing the product is estimated as ₹1,00,000. Variable cost for producing the product is ₹100. Market survey indicated that the product selling price could be ₹200. The break-even quantity is

[A] 1000

[B] 2000

[C] 500

[D] 100

27. ABC analysis divides on-hand inventory into three classes based on

[A] unit price

[B] the number of units on hand

[C] annual demand

[D] annual consumption values

28. What precise movement does CMM have?

[A] precise movement in x coordinate only

[B] precise movement in x and y coordinates

[C] precise movement in y and z coordinates

[D] precise movement in x, y and z coordinates

29. In a super-critical boiler, the pressure range is

[A] 50 to 100 kg/cm^2

[B] 100 to 150 kg/cm^2

[C] 150 to 200 kg/cm^2

[D] 225 to 250 kg/cm^2

30. A 10 mm diameter electrical conductor is covered by an insulation of 2 mm thickness. The conductivity of the insulation is 0·08 W/mK and the convection coefficient at the insulation surface is 10 W/m^2K. Additions of further insulation of the same material will

[A] decrease heat loss to a maximum and then increase heat loss

[B] increase heat loss to a maximum and then decrease heat loss

[C] increase heat loss continuously

[D] decrease heat loss continuously

31. Water is being heated from hot exhaust gases in a shell and tube type heat exchanger. The heat capacity of water is 4000 J/K and heat capacity of gases is 1000 J/K. If heat transfer surface area is 20 m^2 and overall heat transfer coefficient is 200 W/m^2K, the NTU of the heat exchanger is

[A] 4

[B] 6

[C] 9

[D] 2

32. The specific heat ratio in a parallel flow heat exchanger is 0·420. The lower capacity rate is 800 W/K and the overall heat transfer coefficient is given as 800 W/m^2K. To get the effectiveness of 0·52, what should be the area of heat exchanger?

[A] 0·64 m^2

[B] 0·75 m^2

[C] 0·85 m^2

[D] 0·94 m^2

33. The temperature distribution along a pin fin was found to vary with distance x as $T = 6x^2 - 5x + 3$, where x is in meter. Take thermal conductivity of fin material as 0·75 W/mK. The heat transfer from the base of the fin is

[A] 3·75 W/m^2

[B] 4·01 W/m^2

[C] 5·22 W/m^2

[D] 6·32 W/m^2

34. A weight of 500 N is supported by two metallic ropes as shown in the figure. The values of tensions T_1 and T_2 are respectively

[A] N and 250 N

[B] N and 433 N

[C] 353·5 N and N

[D] N and 353 N

35. A car moving with uniform acceleration covers 500 m in a 5-second interval and covers 800 m in the next 5-second interval. The acceleration in the car is

[A] 8 m/s^2

[B] 10 m/s^2

[C] 50 m/s^2

[D] 25 m/s^2

36. The equation $v^2 - u^2 = 2as$, where v and u are final and initial velocities respectively, a is acceleration and s is displacement, is applicable for

[A] variable acceleration of a point

[B] constant acceleration of a point

[C] constant velocity of a point

[D] all possible motions of a point

37. If the length of a column is tripled, the critical load becomes

[A] of the original value

[B] of the original value

[C] of the original value

[D] of the original value

38. Virtual work is the work performed

[A] by actual forces

[B] by assuming possible displacements

[C] in overcoming constraints

[D] by actual displacements

39. A body starting from rest moves in a straight line with its equation of motion being $s = 2t^3 - 3t^2 + 2t + 1$, where s is the displacement in metres and t is the time in seconds. Its acceleration after one second is

[A] 3 m/s^2

[B] 2 m/s^2

[C] 6 m/s^2

[D] 12 m/s^2

40. A cantilever beam is under uniformly distributed load. The shear force and bending moment diagram of the beam will be respectively

[A] linear line and parabolic curve

[B] parabolic curve and exponential curve

[C] parabolic curve and linear line

[D] parabolic curve and cubic curve

41. Two shafts are to be connected by a belt drive. Centre distance between the shafts is 10 m and it is required that the driven shaft rotates opposite to the driving shaft. Which of the following drives will be most appropriate?

[A] Flat belt — open drive

[B] V belt — open drive

[C] Flat belt — crossed drive

[D] Belt drive is not suitable

42. Which one of the following sets of acceleration is involved in the motion of the piston inside the cylinder of a uniformly rotating cylinder mechanism?

[A] Radial and tangential accelerations

[B] Coriolis and radial accelerations

[C] Gyroscopic and tangential accelerations

[D] Coriolis and gyroscopic accelerations

43. Match the List—I (Kinematic Inversions) with List—II (Applications) :

List—I (Kinematic Inversions)	**List—II (Applications)**
(a)	(1) Hand pump
(b)	(2) Compressor
(c)	(3) Whitworth Quick Return Mechanism
(d)	(4) Oscillating cylinder engine

[A] *(a)*-1, *(b)*-3, *(c)*-2, *(d)*-4

[B] *(a)*-2, *(b)*-3, *(c)*-1, *(d)*-4

[C] *(a)*-3, *(b)*-2, *(c)*-4, *(d)*-1

[D] *(a)*-2, *(b)*-3, *(c)*-4, *(d)*-1

44. If the speed of the engine varies between 380 r.p.m. and 420 r.p.m. in a cycle of operation, the coefficient of fluctuation of speed will be

[A] 0·1

[B] 0·2

[C] 0·3

[D] 0·4

45. For a critically damped system, the vibratory motion will be

[A] zero

[B] harmonic

[C] periodic

[D] aperiodic

46. The mass moments of inertia of two rotors in a two-rotor system are 200 kgm^2 and 100 kgm^2. The length of the shaft of uniform diameter between the rotors is 105 cm. The distance of node from the rotor of lower moment of inertia is

[A] 70

[B] 80

[C] 90

[D] 110

47. The critical speed of a uniform shaft with a rotor at the centre of the span can be reduced by

[A] increasing the shaft diameter

[B] increasing the rotor mass

[C] reducing the shaft length

[D] reducing the rotor mass

48. Select the ***correct*** statement.

[A] In boundary lubrication, lubricant is present only at the boundary

[B] In boundary lubrication, there is no lubricant

[C] In hydrodynamic lubrication, lubricant is supplied under pressure

[D] In hydrostatic lubrication, lubricant is supplied under pressure

49. In a plate clutch, axial force is 2 kN. The inside radius of contact surface is 50 mm and the outside radius is 100 mm. For uniform pressure, the mean radius of friction surface will be nearly

[A] 75 mm

[B] 78 mm

[C] 80 mm

[D] 25 mm

50. The static deflection of a shaft under a flywheel is 4 mm, the critical speed in rad/sec will be (take g = 10 m/s^2)

[A] 50

[B] 20

[C] 10

[D] 5

51. Which of the following statements is ***correct*** for ductile materials?

[A] They fail by fracture

[B] They do not obey Hooke's law

[C] They have a clearly defined yield point

[D] Their percentage elongation is less than the brittle materials

52. Decreasing grain size in a polycrystalline material

[A] increases yield strength and corrosion resistance

[B] decreases yield strength and corrosion resistance

[C] increases yield strength but decreases corrosion resistance

[D] decreases yield strength but increases corrosion resistance

53. Normalizing process of heat treatment improves

[A] hardness

[B] strength

[C] machinability

[D] both strength and machinability

54. Find the correct match between List—I (processes) and List—II (products) :

List—I (Processes)	**List—II (Products)**
(a) Die-casting	1. Turbine blades
(b) Investment casting	2. Cast iron pipes
(c) Centrifugal casting	3. Carburetor body
(d) Drop forging	4. Turbine rotors
	5. Connecting rods

[A] *(a)*-3, *(b)*-1, *(c)*-2, *(d)*-5

[B] *(a)*-2, *(b)*-1, *(c)*-5, *(d)*-4

[C] *(a)*-1, *(b)*-3, *(c)*-4, *(d)*-2

[D] *(a)*-3, *(b)*-1, *(c)*-5, *(d)*-2

55. The primary purpose of sprue in casting mould is to

[A] act as a reservoir

[B] feed the casting at a rate consistent with the rate of solidification

[C] help feed the casting until all solidifications take place

[D] Feed molten metal from the pouring basin to the gate

56. In a rolling process, the state of stress of the material undergoing deformation is

[A] pure shear

[B] pure compression

[C] compression and shear

[D] tension and shear

57. In the hole and shaft pair designation of 40 H7/d9, the numbers 7 and 9 indicate

[A] basic size

[B] ease of assembly

[C] accuracy of manufacture

[D] tolerance grade

58. Limit gauges are used to

[A] measure flatness of the component

[B] measure exact size of the component

[C] check if the component dimension lies within permissible limits

[D] measure surface roughness of the component

59. Which of the following statements is ***true***?

[A] A sine bar cannot measure unknown angles

[B] The longer the sine bar, the better the accuracy

[C] The shorter the sine bar, the better the accuracy

[D] Accuracy of a sine bar does not depend on an ambient temperature

60. Cutting tools are provided with large positive rake angle mainly for

[A] better heat dissipation

[B] reducing the magnitude of cutting force

[C] increasing the strength of cutting edge

[D] avoiding rubbing action with the finished surfaces

61. A milling cutter having 12 teeth is rotating at 150 r.p.m. If the feed per tooth is 0·1 mm, the speed in mm per minute is

[A] 120

[B] 150

[C] 170

[D] 180

62. Tool life in the case of a grinding wheel is the time

[A] taken between two successive wheel dressings

[B] taken for a wear of 1 mm on its diameter

[C] taken between two successive regrinds of the wheel

[D] taken for the wheel to be balanced

63. In Electro-Discharge Machining (EDM), if the thermal conductivity of tools is high and the specific heat of workpiece is low, then the tool wear rate and material removal rate are expected to be respectively

[A] low and high

[B] high and low

[C] low and low

[D] high and high

64. In Abrasive Water Jet (AWJ) machining, kerf taper and surface roughness of machined work-piece are expected to decrease continuously with increase in

[A] abrasive mass flow rate

[B] water pressure

[C] stand-off distance

[D] traverse rate

65. For a completely submerged body with centre of the gravity G and centre of the buoyancy B, the condition of stability is found when

[A] G and B are coincident

[B] G is located below B

[C] G is located above B

[D] G and B are locationally independent

66. The stream function in a two-dimensional flow field is given by . At point $(2, 2)$ the magnitude of the velocity will be

[A]

[B]

[C] 4

[D] 8

67. Which is the correct option of the following statements about steady incompressible forced vortex flow?

P. Velocity is directly proportional to the radius from the centre of the vortex.
Q. Vorticity is zero at all the points in the flow.
R. Shear stress is zero at all the points in the flow.
S. Total mechanical energy per unit mass is constant in the entire flow field.

[A] P and Q
[B] Q and R
[C] P and S
[D] Q and S

68. The predominant forces acting on an element of fluids in the boundary layer over a flat plate in a uniform parallel stream are

[A] viscous and inertial forces
[B] viscous and pressure forces
[C] inertial and pressure forces
[D] viscous and body forces

69. The temperature variation under steady heat conduction across a composite slab of two materials with thermal conductivities k_1 and k_2 is shown in the figure. Which one of the following statements holds?

[A] $k_1 < k_2$
[B] $k_1 = k_2$
[C] $k_1 > k_2$
[D] $k_1 = 0$

70. The emissive power of a black body is P. If its absolute temperature is doubled, the emissive power becomes

[A] $16P$
[B] $8P$
[C] $4P$
[D] $2P$

71. For the same inlet and outlet temperatures of hot and cold fluids, the Log Mean Temperature Difference (LMTD) is

[A] greater for parallel flow heat exchanger than counterflow heat exchanger
[B] greater for counterflow heat exchanger than parallel flow heat exchanger
[C] dependent on the properties of the fluids
[D] the same for both parallel flow and counterflow heat exchangers

72. Which one of the following configurations has the highest fin effectiveness?

[A] Thin, widely spaced fins
[B] Thick, widely spaced fins
[C] Thick, closely spaced fins
[D] Thin, closely spaced fins

73. The COP of a Carnot heat pump operating between 27 °C and 77 °C is

[A] 1·42
[B] 6
[C] 7
[D] 9

74. A heat reservoir at 800 K is brought into contact with the ambient at 200 K for a short time. During this period 12000 kJ of heat is lost by the heat reservoir. The total loss in availability due to this process is

[A] 3000 kJ

[B] 6000 kJ

[C] 9000 kJ

[D] 15000 kJ

75. In the Rankine cycle, when superheated steam is used

[A] steam dryness after expansion increases

[B] steam consumption increases

[C] thermal efficiency decreases

[D] steam dryness after compression increases

76. Clearance volume of a reciprocating compressor is 100 ml and the volume of the cylinder at bottom dead centre is 1·0 litre. The clearance ratio of the compressor is

[A] 1/11

[B] 1/10

[C] 1/9

[D] 1/1·1

77. A steam of moist air (mass flow rate = 10·1 kg/s) with humidity ratio of 0·01 kg/kg dry air mixes with a second stream of superheated water vapour flowing at 0·1 kg/s. Assuming proper and uniform mixing with no condensation, the humidity ratio of the final stream (in kg/kg dry air) is

[A] 0·01

[B] 0·02

[C] 0·03

[D] 0·04

78. Round the clock cooling of an apartment having a load of 300 MJ/day requires an air-conditioning plant of capacity about

[A] 1 ton

[B] 2 tons

[C] 5 tons

[D] 10 tons

79. An oil separator in a refrigeration system is located

[A] just before the compressor

[B] just after the condenser

[C] between the compressor and the condenser

[D] between the evaporator and the expansion valve

80. Factor of safety is the ratio of

[A] working stress and ultimate strength

[B] yield strength and endurance strength

[C] ultimate strength and yield strength

[D] yield strength and working stress

81. Determine torque transmitted on the pinion shaft if torque transmitted on gear shaft is 20 Nm. Consider the gear ratio = 4.

[A] 8 Nm

[B] 5 Nm

[C] 80 Nm

[D] 16 Nm

82. If the radius of a wire stretched by a load is doubled, then its Young's modulus will

[A] be doubled

[B] be halved

[C] be one-fourth

[D] remain unaffected

83. Which of the following materials is most elastic?

[A] Rubber

[B] Plastic

[C] Brass

[D] Steel

84. A boiler shell of 200 cm diameter and plate thickness of 1·5 cm is subjected to an internal pressure of 1·5 MN/m^2, then the hoop stress will be

[A] 30 MN/m^2

[B] 50 MN/m^2

[C] 100 MN/m^2

[D] 200 MN/m^2

85. Stress concentration is caused due to

[A] variation in properties of material from point to point in a member

[B] pitting at points or areas at which loads on a member are applied

[C] abrupt change of section

[D] All of the above

86. The fatigue life of a part can be improved by

[A] electroplating

[B] polishing

[C] coating

[D] shot peening

87. The binding material used in cemented carbide cutting tool is

[A] graphite

[B] tungsten

[C] nickel

[D] cobalt

88. In EDM, the tool is made up of

[A] copper

[B] HSS

[C] cast iron

[D] plain carbon steel

89. A steel bar of 40 mm × 40 mm square cross-section is subjected to an axial compressive load of 200 kN. If the length of the bar is 2 m and E = 200 GPa, the contraction of the bar will be

[A] 2·70 mm

[B] 1·25 mm

[C] 4·05 mm

[D] 5·40 mm

90. Machinability of steel is improved by the addition of

[A] sulphur

[B] silicon

[C] phosphorous

[D] All of the above

91. For a ductile material, toughness is a measure of

[A] resistance to scratching

[B] ability to absorb energy up to fracture

[C] ability to absorb energy till elastic limit

[D] resistance to indentation

92. The process of reheating the martensitic steel to reduce its brittleness without any significant loss in its hardness is

[A] normalizing

[B] annealing

[C] quenching

[D] tempering

93. Centrifugally casted products have

[A] large grain structure with high porosity

[B] fine grain structure with high density

[C] fine grain structure with low density

[D] segregation of slug towards the outer skin of the casting

94. Disposable patterns are made up of

[A] wood

[B] rubber

[C] metal

[D] polystyrene

95. Negative allowance is provided on the pattern to take care of the

[A] distortion allowance

[B] draft allowance

[C] machining allowance

[D] shake allowance

96. Anisotropy in rolled components is caused by

[A] change in dimension

[B] scale formation

[C] closure of defects

[D] grain orientation

97. A uniformly distributed load of 20 kN/m acts on a simply supported beam of rectangular cross-section of width 20 mm and depth 60 mm. What is the maximum bending stress acting on the beam of 5 m?

[A] 5030 MPa

[B] 6600 MPa

[C] 5208 MPa

[D] Insufficient data

98. The horse power transmitted by a belt is dependent upon

[A] the tension on tight and slack sides of the belt

[B] the speed of pulley

[C] the radius of pulley

[D] All of the above

99. The correct sequence of elements of 18-4-1 HSS tool is

[A] W, Cr, V

[B] Mo, Cr, V

[C] Cr, Ni, C

[D] Cu, Zn, Sn

100. The function of flux in submerged arc welding is

[A] to completely cover the welded zone

[B] to prevent oxidation of joint

[C] to prevent spattering of molten metal

[D] All of the above

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