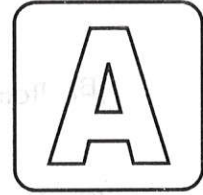| DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO |

Test Booklet No. :

Series

TEST BOOKLET

01709

Paper—II

Ⓐ

(MECHANICAL ENGINEERING)

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

Read the following instructions carefully before you begin to answer the questions :

1. The name of the Subject, Roll Number as mentioned in the Admission Certificate, Test Booklet No. and Series are to be written legibly and correctly in the space provided on the Answer-Sheet with Black/Blue ballpoint pen.

2. **Answer-Sheet without marking Series as mentioned above in the space provided for in the Answer-Sheet shall not be evaluated.**

3. All questions carry equal marks. **The Answer-Sheet should be submitted to the Invigilator.**

Directions for giving the answers : Directions for answering questions have already been issued to the respective candidates in the 'Instructions for marking in the OMR Answer-Sheet' along with the Admit Card and Specimen Copy of the OMR Answer-Sheet.

Example :

Suppose the following question is asked :

The capital of Bangladesh is
 (A) Chennai
 (B) London
 (C) Dhaka
 (D) Dhubri

You will have four alternatives in the Answer-Sheet for your response corresponding to each question of the Test Booklet as below :

Ⓐ Ⓑ Ⓒ Ⓓ

In the above illustration, if your chosen response is alternative (C), i.e., Dhaka, then the same should be marked on the Answer-Sheet by blackening the relevant circle with a Black/Blue ballpoint pen only as below :

Ⓐ Ⓑ ⬤ Ⓓ

 The example shown above is the only correct method of answering.

4. Use of eraser, blade, chemical whitener fluid to rectify any response is prohibited.

5. Please ensure that the Test Booklet has the required number of pages (16) immediately after opening the Booklet. In case any page(s) is/are missing, please report the same to the Invigilator.

6. No candidate shall be admitted to the Examination Hall/Room 20 minutes after the commencement of the examination.

7. No candidate shall leave the Examination Hall/Room without prior permission of the Supervisor/ Invigilator. No candidate shall be permitted to hand over his/her Answer-Sheet and leave the Examination Hall/Room before expiry of the full time allotted for each paper.

8. No Mobile Phone, Electronic Communication Device, etc., are allowed to be carried inside the Examination Hall/Room by the candidates. Any Mobile Phone, Electronic Communication Device, etc., found in possession of the candidate inside the Examination Hall/Room, even if on off mode, shall be liable for confiscation.

9. No candidate shall have in his/her possession inside the Examination Hall/Room any book, notebook or loose paper, except his/her Admission Certificate and other connected papers permitted by the Commission.

10. Complete silence must be observed in the Examination Hall/Room. No candidate shall copy from the paper of any other candidate, or permit his/her own paper to be copied, or give, or attempt to give, or obtain, or attempt to obtain irregular assistance of any kind.

11. This Test Booklet can be carried with you after answering the questions in the prescribed Answer-Sheet.

12. Noncompliance with any of the above instructions will render a candidate liable to penalty as may be deemed fit.

13. No rough work is to be done on the OMR Answer-Sheet. You can do the rough work on the space provided in the Test Booklet.

N.B. : There will be negative marking @ 0·25 per 1 (one) mark against each wrong answer.

/35 **[No. of Questions : 100**

1. For the same compression ratio and heat rejection

   (A) $\eta_{\text{diesel cycle}} > \eta_{\text{Otto cycle}} > \eta_{\text{dual cycle}}$

   (B) $\eta_{\text{Otto cycle}} > \eta_{\text{dual cycle}} > \eta_{\text{diesel cycle}}$

   (C) $\eta_{\text{Otto cycle}} > \eta_{\text{diesel cycle}} > \eta_{\text{dual cycle}}$

   (D) $\eta_{\text{dual cycle}} > \eta_{\text{Otto cycle}} > \eta_{\text{diesel cycle}}$

2. If the latent heat of fusion of ice is 333 kJ/kg at atmospheric pressure and 1 kg of ice melts at 0 °C, then the entropy change is equal to

   (A) 1·22 kJ/kg.K

   (B) −1·22 kJ/kg.K

   (C) 0·82 kJ/kg.K

   (D) −0·82 kJ/kg.K

3. The compression ratio of an IC engine is the ratio of

   (A) swept volume to clearance volume

   (B) swept volume to total volume

   (C) total volume to swept volume

   (D) total volume to clearance volume

4. 'Degree of superheat' is the difference between

   (A) saturation temperature of steam and ambient temperature

   (B) temperature of steam and ambient temperature

   (C) temperature of steam and saturation temperature

   (D) ambient temperature and sensible heat temperature

5. A cycle which consists of two reversible adiabatic processes and two constant pressure processes is known as

   (A) Otto cycle

   (B) Diesel cycle

   (C) Dual cycle

   (D) Brayton cycle

6. A reversible heat engine operating between two temperature reservoirs of 600 K and 300 K absorbs 300 kJ/s. The amount of heat rejected by the engine to the sink is

   (A) 150 kJ/s

   (B) 200 kJ/s

   (C) 100 kJ/s

   (D) 75 kJ/s

7. In a closed system with ideal gas undergoing displacement work, the heat transfer is equal to the work transfer in which of the following processes?

(A) Isothermal process

(B) Isobaric process

(C) Isochoric process

(D) Isentropic process

8. Reversible adiabatic processes are also known as

(A) isothermal process

(B) isentropic process

(C) isochoric process

(D) isobaric process

9. A line perpendicular to X-axis of a Mollier chart will represent

(A) an isothermal process

(B) a throttling process

(C) an isentropic process

(D) an isobaric process

10. The steam available at 1 atmospheric pressure and 130 °C is

(A) wet steam

(B) dry steam

(C) superheated steam

(D) Cannot be ascertained

11. Entropy is defined by the

(A) zeroth law of thermodynamics

(B) first law of thermodynamics

(C) second law of thermodynamics

(D) third law of thermodynamics

12. A diesel engine has a compression ratio of 14 and cut-off takes place at 6% of the stroke, then the cut-off ratio of the engine is

(A) 1·84

(B) 1·78

(C) 2·78

(D) 2·84

13. In steam power plant using steam turbine, which of the following cycles is used?

(A) Brayton cycle

(B) Rankine cycle

(C) Carnot cycle

(D) Modified Rankine cycle

14. Which of the following *does not* fall in the same category of the others?

(A) Economizer

(B) Superheater

(C) Air-preheater

(D) Feed check valve

15. For a steam nozzle, if p_1 = inlet pressure, p_2 = exit pressure and n is the index of isentropic expansion, the mass flow rate per unit area is maximum if

(A) $\dfrac{p_2}{p_1} = \left(\dfrac{2}{n+1}\right)^{\frac{n-1}{n}}$

(B) $\dfrac{p_2}{p_1} = \left(\dfrac{2}{n+1}\right)^{\frac{n+1}{n}}$

(C) $\dfrac{p_2}{p_1} = \left(\dfrac{2}{n+1}\right)^{\frac{n}{n+1}}$

(D) $\dfrac{p_2}{p_1} = \left(\dfrac{2}{n+1}\right)^{\frac{n}{n-1}}$

16. At 100% relative humidity, wet-bulb temperature

(A) is more than the dew point

(B) is less than the dew point

(C) is same as the dew point

(D) has no relation with the dew point

17. The chemical formula of R11 refrigerant is

(A) CCl_3F

(B) CCl_2F_2

(C) CCl_3F_3

(D) $C_2Cl_2F_4$

18. Cetane number is determined by comparing the performance of diesel oil with which of the following hydrocarbons?

(A) Cetane

(B) Mixture of cetane and iso-octane

(C) Mixture of cetane and alpha-methyl naphthalene

(D) Mixture of cetane and tetra-ethyl lead

19. The heat rate of a power plant is equal to

(A) heat input to the plant per unit time

(B) unit shaft output per unit heat input

(C) rate of heat of heat input required to produce unit shaft output

(D) None of the above

20. The major constituent of natural gas is

(A) propane

(B) butane

(C) ethane

(D) methane

21. The plant load factor of power plant is equal to

(A) $\dfrac{\text{average load over a given time interval}}{\text{peak load during the same time interval}}$

(B) $\dfrac{\text{average load}}{\text{rated capacity of the plant}}$

(C) $\dfrac{\text{actual maximum demand}}{\text{total connected demand}}$

(D) $\dfrac{\text{sum of the individual consumer groups}}{\text{actual peak load of the system}}$

22. In fluid mechanics, the continuity equation is a mathematical statement embodying the principle of

(A) conservation of momentum

(B) conservation of mass

(C) conservation of energy

(D) conservation of flow

23. The SI unit of kinematic viscosity is

(A) m^2/sec

(B) m/sec

(C) m/sec^2

(D) $kg/m.sec$

24. A body floats in stable equilibrium, when

(A) the centre of gravity is below the centre of buoyancy

(B) the metacentre is above the centre of gravity

(C) the centre of gravity is above the centre of buoyancy

(D) the metacentre is below the centre of gravity

25. Pitot tube is used for measuring

(A) velocity of flow

(B) pressure of flow

(C) flow rate

(D) total energy

26. The boundary layer separation occurs, when

(A) $\left(\dfrac{dp}{dx}\right)_{y=0} < 0$

(B) $\left(\dfrac{dp}{dx}\right)_{y=0} = 0$

(C) $\left(\dfrac{dp}{dx}\right)_{y=0} > 0$

(D) None of the above

27. The pressure intensity at a point in water column is given by $4\ N/cm^2$. The corresponding height of water is

(A) 3 m

(B) 4 m

(C) 5 m

(D) 6 m

28. The square root of the ratio of the inertia force of a flowing fluid to the elastic force is known as

(A) Reynolds' number

(B) Mach's number

(C) Weber's number

(D) Euler's number

29. In pipe flow, the minor losses are those

(A) which depend on the length of the pipeline

(B) caused by friction and are thus also called friction loss

(C) which have small magnitude

(D) which are caused on account of total disturbance produced by such fittings as valves, bends, etc.

30. In case of laminar flow, the loss of pressure head is proportional to

(A) velocity

(B) (velocity)^2

(C) (velocity)^3

(D) velocity/2

31. A fully developed laminar viscous flow through a circular tube has the ratio of maximum velocity to average velocity as

(A) 1·5

(B) 2·0

(C) 2·5

(D) 3·0

32. A steam function is given by

$$\psi = 4x - 3y$$

The resultant velocity of flow is

(A) 4

(B) 5

(C) 6

(D) 7

33. The value of coefficient of friction for viscous flow in a circular pipe is given by

(A) $f = \dfrac{4}{Re}$

(B) $f = \dfrac{8}{Re}$

(C) $f = \dfrac{16}{Re}$

(D) $f = \dfrac{32}{Re}$

[where Re = Reynolds' number]

34. In turbulent flow, the velocity distribution is a function of the distance y measured from the boundary surface and shear friction velocity and follows a

(A) linear law

(B) hyperbolic law

(C) parabolic law

(D) logarithmic law

35. Which of the following processes uses non-consumable electrode?

(A) MIG

(B) TIG

(C) SAW

(D) Thermit welding

36. In electro discharge machining (EDM), metal removal takes place as

(A) chemical reaction of metal

(B) dissolution of metal

(C) erosion of metal

(D) None of the above

37. Hardness of steel greatly improves with

(A) annealing

(B) cyaniding

(C) normalizing

(D) tempering

38. Which of the following mechanical properties a metal should possess to enable it to be mechanically formed?

(A) Ductility

(B) Malleability

(C) Elasticity

(D) Machinability

39. For improving the strength of steel at elevated temperature, which one of the following alloying elements is used?

(A) Copper

(B) Tungsten

(C) Aluminium

(D) Zinc

40. Sprue in casting refers to

(A) gate

(B) runner

(C) riser

(D) vertical passage

41. In centrifugal casting, the impurities are

(A) uniformly distributed

(B) tapped near the mean radius of casting

(C) collected at the centre of casting

(D) forced towards the outer surface

42. Cobalt is added to HSS tools to

   (A) increase its wear resistance

   (B) increase hot hardness

   (C) lower critical range of temperature

   (D) increase its toughness

43. Tool signature comprises of

   (A) 4 elements

   (B) 5 elements

   (C) 7 elements

   (D) 6 elements

44. Cold working of metal increases

   (A) tensile strength

   (B) hardness

   (C) yield strength

   (D) All of the above

45. Chip with built-up edge can be expected when machining

   (A) hard material

   (B) brittle material

   (C) tough material

   (D) ductile material

46. Among the conventional machining processes, maximum specific energy is consumed in

   (A) turning

   (B) drilling

   (C) planing

   (D) grinding

47. Hardness of green sand mould increases with

   (A) increase in moisture content beyond 6%

   (B) increase in permeability

   (C) decrease in permeability

   (D) increase in both moisture content and permeability

48. Which of the following is the correct temperature range for hot extrusion of aluminium?

   (A) 350 °C–500 °C

   (B) 1350 °C–1500 °C

   (C) 1000 °C–1200 °C

   (D) 2000 °C–2200 °C

49. The diameter of a shaft subjected to torque alone is doubled, then horsepower P can be increased to

   (A) $16P$

   (B) $8P$

   (C) $4P$

   (D) $2P$

50. The ratio of coil diameter to wire diameter in case of a circular helical spring is known as

   (A) spring number

   (B) spring index

   (C) spring rate

   (D) spring diameter ratio

51. If d = pcd of a spur gear, z = number of teeth, then module (m) is

(A) dz

(B) d/z

(C) z/d

(D) $z+d$

52. If we need to design a hydro-dynamically operated journal bearing, then the bearing characteristic number $\left(\dfrac{ZN}{p}\right)$ must be at least _____ times of the bearing modus.

(A) 2

(B) 3

(C) 4

(D) 5

53. The life of a bearing is designated in terms of

(A) millions of revolution

(B) hours of operation

(C) both millions of revolution and hours of operation

(D) Life of bearing is not expressed at all

54. A composite slab has two layers of different materials having thermal conductivities k_1 and k_2. If each layer has the same thickness, then the equivalent thermal conductivity of the slab is

(A) $k_1 + k_2$

(B) $k_1 k_2$

(C) $\dfrac{(k_1 + k_2)}{k_1 k_2}$

(D) $\dfrac{2 k_1 k_2}{(k_1 + k_2)}$

55. Two beams, one having square cross-section and another circular cross-section are subjected to same amount of bending moment. If the cross-sectional area and material are same, then

(A) maximum bending stress developed in both beams are same

(B) circular beam experiences more bending stress

(C) square beam experiences more bending stress

(D) both will experience same deflection

56. A beam of 8 m long is fixed at its ends. It carries a uniformly distributed load of 4500 N/m over the whole span. The maximum bending moment is

(A) 24 kN.m

(B) 20 kN.m

(C) 36 kN.m

(D) 39 kN.m

57. Hooke's law holds up to

(A) yield point

(B) elastic point

(C) breaking point

(D) limit of proportionality

58. Two parallel and coplanar shafts are connected by gears having teeth parallel to the shaft. This arrangement is called

(A) spur gear drive

(B) helical gear drive

(C) bevel gear drive

(D) spiral gear drive

59. Which of the following is used to convert a rotational motion into a translational motion?

(A) Bevel gear

(B) Double-helical gear

(C) Worm gear

(D) Rack and pinion gear

60. A planar mechanism has 8 links and 10 rotatory joints. The number of degrees of freedom of the mechanism, using Grubler's criterion, is

(A) 0

(B) 1

(C) 2

(D) 3

61. A Hartnell governor is

(A) pendulum-type governor

(B) spring-loaded governor

(C) dead weight governor

(D) inertial governor

62. For an elastic collision, the value of coefficient of restitution is equal to

(A) 0

(B) 0·5

(C) 1

(D) 1·5

63. The SI unit of force is

(A) newton

(B) dyne

(C) joule

(D) watt

64. If the resultant of two concurrent forces is zero, then it implies that the two forces are

(A) equal in magnitude

(B) equal in magnitude and same in direction

(C) equal in magnitude and opposite in direction

(D) equal in magnitude and perpendicular to each other

65. A coplanar force and a coplanar couple acting on a rigid body

(A) balance each other

(B) cannot balance each other

(C) produce moment of a couple

(D) None of the above

66. When trying to turn a key into a lock, then which of the following is applied?

(A) Coplanar force

(B) Non-coplanar force

(C) Concurrent force

(D) Couple

67. The second moment of area about centroidal X-axis of a rectangle having width b and height h will be

(A) $\dfrac{bh^3}{12}$

(B) $\dfrac{bh^3}{3}$

(C) $\dfrac{hb^3}{12}$

(D) $\dfrac{hb^3}{3}$

68. The kinetic energy of a body which is rotating depends on

(A) angular speed only

(B) square of angular speed only

(C) mass only

(D) mass and angular speed

69. A hinge support constrains

(A) transitional motion along the x-direction

(B) transitional motion along the xy-plane

(C) rotational motion perpendicular to the axis

(D) transitional motion along the xy-plane and rotational motion perpendicular to the axis

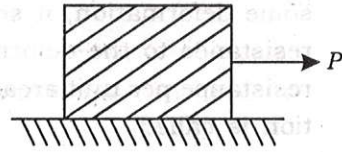**70.** The conditions of equilibrium for non-concurrent force systems are

(A) $\Sigma F_x = 0,\ \Sigma F_y = 0$

(B) $\Sigma F_x = 0,\ \Sigma F_y = 0,\ \Sigma F_z = 0$

(C) $\Sigma F_x = 0,\ \Sigma F_y = 0,\ \Sigma M_z = 0$

(D) $\Sigma F_x = 0,\ \Sigma F_y = 0,\ \Sigma F_z = 0,$
    $\Sigma M_x = 0,\ \Sigma M_y = 0,\ \Sigma M_z = 0$

71. A block of 200 kg mass rests on a rough surface plane as shown in the figure below :

The coefficient of friction (static) between the contact surface is 0·3. The horizontal force (P) required to just pull the block is

(A) 458·6 N

(B) 588·6 N

(C) 688·6 N

(D) 788·6 N

72. In case of simple harmonic motion, the ratio of acceleration to displacement is a constant, which is

(A) ω

(B) ω^2

(C) $1/\omega$

(D) $1/\omega^2$

73. The cam and follower without a spring forms a

(A) lower pair

(B) higher pair

(C) self-closed pair

(D) forced-closed pair

74. When some external system of forces acts on a body, it undergoes some deformation. As the body undergoes some deformation, it sets up some resistance to the deformation. This resistance per unit area to deformation is called

(A) strain

(B) stress

(C) pressure

(D) modulus of elasticity

75. The ratio of linear stress to the linear strain is called

(A) modulus of rigidity

(B) modulus of elasticity

(C) bulk modulus

(D) Poisson's ratio

76. When a bar is cooled to $-5\,°C$, it will develop

(A) no stress

(B) shear stress

(C) tensile stress

(D) compressive stress

77. A tensile test is performed on a round bar. After fracture, it was found that the diameter remains approximately same at fracture. The material under test was

(A) mild steel

(B) cast iron

(C) glass

(D) copper

78. In compression test, the fracture of cast iron specimen would occur along

(A) the axis of load

(B) an oblique plane

(C) at right angles to the axis of the specimen

(D) Would not occur

79. The emissivity for a blackbody is

(A) 0

(B) 0·5

(C) 0·75

(D) 1·0

80. The unit of Stefan-Boltzmann constant is

(A) $watt/m.K$

(B) $watt/m^2.K^2$

(C) $watt/m^2.K^4$

(D) $watt/m.K^2$

81. Which of the following materials has maximum ductility?

(A) Mild steel

(B) Copper

(C) Nickel

(D) Aluminium

82. The stiffness is the ability of a material to resist

(A) deformation under stress

(B) fracture due to high impact loads

(C) externally applied forces with breakdown or yielding

(D) None of the above

83. Break-even analysis shows profit, when

(A) sales revenue > total cost

(B) sales revenue = total cost

(C) sales revenue < total cost

(D) variable cost < fixed cost

84. In PERT network, how many time estimates are there for an activity?

(A) 2

(B) 3

(C) 4

(D) 6

85. The time of completion of a PERT network follows which probability distribution?

(A) Binomial

(B) Normal

(C) Hypergeometric

(D) Poisson

86. In ABC analysis of inventory, the C items are those which represent

(A) small percentage of the total annual consumption value

(B) high percentage of the total annual consumption value

(C) small percentage of closing inventory value

(D) high percentage of closing inventory value

87. Product layout is employed for

(A) batch production

(B) continuous production

(C) effective utilization of machine

(D) All of the above

88. The symbol 'V' in work study represents

(A) operation

(B) inspection

(C) delay

(D) storage

89. Find the odd one out from the following list of quality control charts.

(A) $\bar{X}$, R-chart

(B) p-chart

(C) np-chart

(D) U-chart

90. 5S-philosophy is applied to

(A) inventory management

(B) financial management

(C) maintenance management

(D) manpower management

91. The ratio of maximum fluctuation of energy to the work done per cycle is called

(A) fluctuation of energy

(B) maximum fluctuation of energy

(C) coefficient of fluctuation of energy

(D) modulation of energy

92. Babbitt metal contains

(A) 50% tin and 50% antimony

(B) 66% tin, 30% copper and 4% antimony

(C) 88% tin, 4% copper and 8% antimony

(D) 92% tin, 6% copper and 2% antimony

93. Which of the following metals is used in making electrical resistance wire for electric furnaces and heating elements?

(A) Babbitt metal

(B) Monel metal

(C) Nichrome

(D) Phosphor bronze

94. The moderator generally used in nuclear power plant is

(A) graphite

(B) heavy water

(C) concrete

(D) graphite and concrete

95. The control rods in the control system of a nuclear reactor are used to

(A) absorb excess neutrons

(B) control fuel consumption

(C) control temperature

(D) All of the above

96. Which of the following *does not* fall in the category of 'prime-movers'?

(A) Steam turbine

(B) Gas turbine

(C) Waste-heat turbine

(D) Compressor

97. If in a truss, n = number of members and j = number of joints, then a perfect frame will satisfy which of the following relations?

(A) $j = 2n - 3$ (B) $n = 2j - 3$

(C) $j = 2n + 3$ (D) $n = 2j + 3$

98. The ratio of maximum displacement of the forced vibration to the deflection due to static force, is known as

(A) damping factor

(B) damping coefficient

(C) resonance factor

(D) magnification factor

99. Natural frequency of a system is due to

(A) free vibration

(B) forced vibration

(C) resonance

(D) damping

100. Rotating shafts tend to vibrate violently in transverse directions at constant speed. The speed is called

(A) critical speed

(B) whirling speed

(C) whipping speed

(D) All of the above

* * *

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