

ENGINEERING SERVICES
EXAMINATION-2014

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

T.B.C. : B-DMHH-N-NFA

Test Booklet Series

Serial No.

66813

TEST BOOKLET
MECHANICAL ENGINEERING
Paper I

A

Time Allowed : Two Hours

Maximum Marks : 200

INSTRUCTIONS

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5. You have to mark your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
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9. Sheets for rough work are appended in the Test Booklet at the end.
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 - (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third (0.33)** of the marks assigned to that question will be deducted as penalty.
 - (ii) If a candidate gives more than one answer, it will be treated as **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
 - (iii) If a question is left blank i.e., no answer is given by the candidate, there will be **no penalty** for that question.

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1. Along the 'triple line' in a p - v diagram showing all three phases of water, which one of the following statements is correct?

- (a) A substance has the same pressure and temperature but different specific volume.
- (b) A substance has same temperature and specific volume but different pressure
- (c) A substance has same specific volume and pressure but different temperature
- (d) A substance has same specific volume, pressure and temperature

2. Internal energy of a system is dependent on the following aspects :

- 1. Molecular weight
- 2. Molecular structure
- 3. Degree of molecular activity

Which of the above are correct?

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

3. In a cyclic process, the heat transfer are +30 J, -50 J, -10 J and +60 J. The net work for the cyclic process is

- (a) 30 Nm
- (b) 40 Nm
- (c) 50 Nm
- (d) 60 Nm

4. A researcher claims that he has developed an engine, which while working between source and sink temperatures of 377°C and 27°C rejects only 50% of absorbed heat. What will his engine be?

- (a) An impossible engine
- (b) A Stirling engine
- (c) A reversible engine
- (d) A practical engine

5. A reversible engine works between temperature limits of 260°C and 60°C . To improve the performance, we have to

- (a) Raise the source temperature to 300°C
- (b) Lower the sink temperature to 30°C
- (c) Insulate the engine
- (d) None of the above

6. In a real gas equation $pv = zRT$, depending on the values of pressure and temperature of the real gas, the value of z

- (a) Should always be less than 1
- (b) May be less than 1, may be greater than 1 or equal to 1
- (c) Should always be greater than 1
- (d) Should always be equal to 1

7. A system executes a cyclic process during which there are two processes as given below :

$${}_1Q_2 = 460 \text{ kJ}, {}_2Q_1 = -100 \text{ kJ}, \text{ and} \\ {}_1W_2 = 210 \text{ kJ}$$

What will be work interaction in process ${}_2W_1$?

- (a) 100 kJ
 - (b) -210 kJ
 - (c) 150 kJ
 - (d) -150 kJ
8. For the same compression ratio, the efficiency of an air standard Otto cycle is
- (a) More than the efficiency of an air standard Diesel cycle.
 - (b) Less than the efficiency of an air standard Diesel cycle
 - (c) Equal to the efficiency of an air standard Diesel cycle
 - (d) None of the above

9. A Carnot engine operates between 37°C and 347°C . If the engine produces 620 kJ of work, the entropy change during heat addition is

- (a) 1 kJ/K
- (b) 2 kJ/K
- (c) 3 kJ/K
- (d) 4 kJ/K

10. An amount of 1000 kJ of heat is added to a system during a constant pressure vapourization process at a temperature of 227°C . The available energy added to the system, if the temperature of the surroundings is 27°C , is

- (a) 600 kJ
- (b) 500 kJ
- (c) 400 kJ
- (d) 300 kJ

11. Consider the following statements :

1. In an ideal gas, there are no inter molecular forces of attraction and repulsion.
2. At very low pressure, all gases and vapours approach ideal gas behaviour.
3. Enthalpy of an ideal gas depends only on temperature.

Which of the above statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

12. Consider the following statements pertaining to the properties of perfect, non reacting gas mixtures :

1. The total volume of a mixture is the sum of partial volumes at the same pressure and temperature.
2. The entropy of a mixture of gases is the same as the entropies of the constituents.
3. The total pressure of a mixture of gases is the sum of the partial pressures of the substances.
4. The mole fraction of a mixture of gases is equal to both pressure and volume fraction.

Which of the above statements is/are correct ?

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 3 only
- (c) 1, 2 and 4 only
- (d) 3 and 4 only

13. An inventor claims to have developed a refrigeration unit which maintains -10°C in the refrigerator which is kept in a room where the surrounding temperature is 25°C and which has COP 8.5. His claim is

- (a) Valid
- (b) Marginally correct
- (c) Invalid
- (d) None of the above

14. An Otto cycle has a compression ratio of 8. If 250 kJ of work is extracted from the cycle, the heat rejected by the cycle is

- (a) 500 kJ
- (b) 442.69 kJ
- (c) 331.4 kJ
- (d) 192.69 kJ

15. In an engine working on air standard Stirling cycle the temperature at the beginning of isothermal compression is 127°C . The engine thermal efficiency is 50%. The specific heat of air at constant volume is C_v . The heat transferred to the regenerator is

- (a) $200 C_v$ kJ/kg
- (b) $300 C_v$ kJ/kg
- (c) $400 C_v$ kJ/kg
- (d) $500 C_v$ kJ/kg

16. An ideal spark ignition engine has a compression ratio of 9. What is its Air standard efficiency if ratio of specific heats is 1.5 ?

- (a) 63%
- (b) 67%
- (c) 70%
- (d) 72%

17. A Carnot heat pump works between 27°C and 327°C . What will be its COP?

- (a) 0.09
- (b) 1.00
- (c) 1.09
- (d) 2.0

18. Practically it is not feasible to design an engine which closely follows the 'Carnot cycle' for the following reasons:

1. Transfer of heat energy at constant temperature is very difficult to achieve
2. Isentropic processes are very fast processes
3. It makes use of smaller pressure ratios
4. Thermal efficiency is not a function of source and sink temperatures

Which of the above reasons are correct?

- (a) 1 and 2
- (b) 2 and 3
- (c) 3 and 4
- (d) 4 and 1

19. Two identical finite bodies of constant heat capacity at temperatures T_1 and T_2 are available to do work in a heat engine. The final temperature T_f reached by the bodies on delivery of maximum work is

(a) $T_f = \frac{T_1 + T_2}{2}$

(b) $T_f = \sqrt{T_1 T_2}$

(c) $T_f = \frac{T_1 - T_2}{2}$

(d) $T_f = \sqrt{T_1^2 + T_2^2}$

20. The mechanical efficiency of a single cylinder four stroke engine is 80%. If the frictional power is estimated to be 25 kW, the indicated power will be

- (a) 100 kW
- (b) 125 kW
- (c) 150 kW
- (d) 175 kW

21. A single cylinder four stroke engine operating at 80% of mechanical efficiency develops a brake power of 60 kW. The indicated power and the power lost due to friction respectively are

- (a) 40 kW and 15 kW
- (b) 75 kW and 20 kW
- (c) 40 kW and 20 kW
- (d) 75 kW and 15 kW

22. The following reasons, are mentioned while recommending supercharging for the engines used in aeroplanes and submarines :

1. More volumetric efficiency, better combustion and increased power output.
2. Higher peak pressure, increased temperature and smaller size.

Which of the above reasons is/are correct ?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

23. Consider the following statements regarding supercharging of Diesel engines :

1. The mechanical efficiency of a supercharged Diesel engine is slightly better than that of naturally aspirated engine.
2. There is reduction in smoke in the case of supercharged engine in the overload operation.
3. Increased valve overlap is used in supercharged engine.

Which of the above statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

24. In Diesel engines, the control of black smoke in exhaust can be achieved by :

1. Running the engine at lower load.
2. Maintaining the injection system perfect.
3. Using Diesel fuel of higher Cetane number.

Which of the above statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

25. The source of energy which keeps the sun shining for billions of years is

- (a) Combustion of Hydrogen
- (b) Nuclear fusion of light elements
- (c) Nuclear fission of heavy elements
- (d) Interaction of currents in the interior of the sun with the galactic magnetic field

26. Which one of the following statements is correct ?

- (a) During heating and humidification process, humidity ratio decreases
- (b) During cooling and dehumidification process, humidity ratio increases
- (c) During cooling and dehumidification process, dry bulb temperature increases
- (d) During heating and humidification process, dry bulb temperature increases

27. A dimensionless quantity that connects the link between velocity flow field and the temperature field is

- (a) Nusselt number
- (b) Prandtl number
- (c) Reynolds number
- (d) Grashof number

28. The conduction heat diffuses in a material when the material has :

- 1. High thermal conductivity
- 2. Low density
- 3. High specific heat
- 4. High viscosity

Which of the above are correct ?

- (a) 1 and 2
- (b) 2 and 3
- (c) 3 and 4
- (d) 4 and 1

29. In an equation of Fourier law of heat conduction, heat flow through a body per unit time is $Q = -kA \frac{dT}{dx}$, the negative sign of k in this equation is to take care of

- (a) Decreasing temperature along the direction of increasing thickness
- (b) Increasing temperature along the direction of increasing thickness
- (c) Constant temperature along the direction with constant thickness
- (d) All of the above

30. A flat wall with a thermal conductivity of 0.2 kW/mK has its inner and outer surface temperatures 600°C and 200°C respectively. If the heat flux through the wall is 200 kW/m^2 , what is the thickness of the wall ?

- (a) 10 cm
- (b) 20 cm
- (c) 30 cm
- (d) 40 cm

31. Which of the following thermodynamic properties are intensive properties ?

- 1. Density
- 2. Entropy
- 3. Viscosity

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 1 and 3 only

32. In a concentric double-pipe heat exchanger where one of the fluids undergoes phase change

- (a) The two fluids should flow opposite to each other
- (b) The two fluids should flow parallel to each other
- (c) The two fluids should flow normal to each other
- (d) The directions of flow of the two fluids are of no consequence

33. The characteristic length for computing Grashof number in the case of horizontal cylinder is

- (a) The length of the cylinder
- (b) The diameter of the cylinder
- (c) The perimeter of the cylinder
- (d) The radius of the cylinder

34. For which of these configurations is a minimum temperature difference required for natural convection to set in

- (a) Fluid near a heated vertical plate
- (b) Fluid near a heated plate inclined at 45° to the vertical
- (c) Fluid over a heated horizontal plate
- (d) Fluid near a heated cylinder

35. A counter flow shell and tube heat exchanger is used to heat water with hot exhaust gases. The water ($c = 4180 \text{ J/kg K}$) flows at the rate of 2 kg/s and the exhaust gases ($c = 1000 \text{ J/kg K}$) flow at the rate of 5 kg/s . If the heat transfer surface area is 32 m^2 and the overall heat transfer coefficient is $200 \text{ W/m}^2\text{K}$, the NTU of the heat exchanger is

- (a) 4.5
- (b) 2.4
- (c) 8.6
- (d) 1.28

36. In a two-fluid heat exchanger, the inlet and outlet temperatures of the hot fluid are 65°C and 40°C respectively. For the cold fluid, these are 15°C and 43°C . The heat exchanger is a

- (a) Parallel flow heat exchanger
- (b) Counter flow heat exchanger
- (c) Mixed flow heat exchanger
- (d) Phase-change heat exchanger

37. In a double-pipe heat exchanger, the cold fluid is water with inlet temperature 20°C and mass flow rate 20 kg/s and the hot fluid water inlet temperature 80°C and mass flow rate 10 kg/s . Assume that for water $C_p = 4.2 \text{ kJ/kg}^\circ\text{C}$, independent of temperature. What is the maximum temperature to which the cold fluid can be heated in a parallel flow and in a counter flow heat exchanger?

- (a) 80°C in both parallel flow and counter flow
- (b) 50°C in both parallel flow and counter flow
- (c) 40°C in parallel flow and 50°C in counter flow
- (d) 40°C in parallel flow and 80°C in counter flow

38. If a body is at 2000 K, the wavelength at which the body emits maximum amount of radiation is

- (a) 1.45 μm
- (b) 1.45 cm
- (c) 0.345 cm
- (d) 0.345 μm

39. An isothermal cubical ($10\text{ m} \times 10\text{ m} \times 10\text{ m}$) blackbody at 200°C is suspended in air. The total radiation emitted by this body to its surroundings will be

- (a) 1702.9 kW
- (b) 1800.7 kW
- (c) 54.4 kW
- (d) 2838.1 kW

40. A 1 m diameter spherical cavity is maintained at a uniform temperature of 500 K. The emissivity of the material of the sphere is 0.5; One 10 mm diameter hole is drilled. The maximum rate of radiant energy streaming through the hole will be

- (a) 2782 W
- (b) 0.139 W
- (c) 1392 W
- (d) 0.278 W

41. For a hemispherical furnace with a flat circular base of diameter D , the view factor from the dome to its base is

- (a) 0.5
- (b) 1
- (c) 0
- (d) 0.32

42. In a vapour compression refrigeration system, the high pressure liquid from the condenser/receiver is cooled below its saturation temperature to

- (a) Reduce the net work per cycle
- (b) Reduce the net refrigerating effect
- (c) Increase the net refrigerating effect
- (d) Reduce the pressure on the high pressure side

43. Specific humidity is defined as Mass of

- (a) Water vapour contained in air-vapour mixture per kg of dry air
- (b) Water vapour contained per kg of air-vapour mixture
- (c) Dry air contained per kg of air-vapour mixture
- (d) None of the above

44. In an ideal Vapour Compression Refrigeration cycle the enthalpy values at salient points are as follows :

At inlet to compressor : 1500 kJ/kg

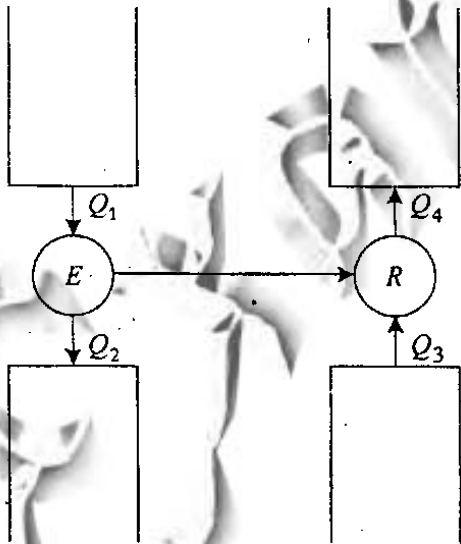
At outlet to compressor : 1800 kJ/kg

At inlet to evaporator : 300 kJ/kg

What is the COP of the cycle ?

- (a) 3
- (b) 4
- (c) 5
- (d) 6

45.



In the figure shown above, E is the heat engine with efficiency of 0.4 and R is the refrigerator. If $Q_2 + Q_4 = 3Q_1$, the COP of the refrigerator will be

- (a) 3.0
- (b) 4.5
- (c) 5.0
- (d) 5.5

46. The COP of an ideal refrigerator is N . If the machine is operated as a heat pump between the same temperature limits, its COP will be

- (a) $N - 1$
- (b) N
- (c) $N + 1$
- (d) $2N$

47. An ideal refrigerator based on reversed Carnot cycle works between -23°C and $+27^\circ\text{C}$. What will be the required power in kW, if a cooling rate of 1.5 kW is desired ?

- (a) 0.25 kW
- (b) 0.3 kW
- (c) 3.25 kW
- (d) 7.5 kW

48. Consider the following functions :

1. Minimizing friction
2. Sealing the gas between suction and discharge ports
3. As a coolant to transfer heat from the crankcase to the compressor shell
4. To dampen the noise generated by moving parts

Which of the above functions do lubricants in refrigeration systems perform ?

- (a) 1, 2, 3 and 4
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 3 and 4 only

49. Consider the following statements for sensible heating. In this process :

1. Wet bulb temperature increases
2. Relative humidity decreases
3. Vapour pressure remains constant

Which of the above statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

50. An air-conditioning system operating on the reversed Carnot cycle is required to remove heat from the room at a rate of 25 kW to maintain its temperature constant at 20°C. The temperature of the surroundings being 35°C, the power required to operate this air-conditioning system will be

- (a) 1.28 kW
- (b) 4.02 kW
- (c) 5.12 kW
- (d) 12.80 kW

51. The pressure inside a soap bubble of 50 mm diameter is 25 N/m² above the atmospheric pressure. The surface tension in soap film would be

- (a) 0.156 N/m
- (b) 0.312 N/m
- (c) 0.624 N/m
- (d) 0.078 N/m

52. A Newtonian fluid is one which

- (a) is viscous but incompressible
- (b) has a linear relationship between the shear stress and the rate of angular deflection
- (c) exhibits an increase in viscosity with increasing rate of deformation
- (d) exhibits a decrease in viscosity with increasing rate of deformation

53. Unlike the viscosity of liquids, the viscosity of gases increases with increasing temperature. This is due to

- (a) Increased cohesive force between the molecules
- (b) Increased momentum transfer in the molecules
- (c) Decreased momentum transfer in the molecules
- (d) Increase in both cohesive force and momentum transfer

54. Manometer is a device used for measuring

- (a) Velocity at a point in a fluid
- (b) Pressure at a point in a fluid
- (c) Discharge of a fluid
- (d) None of the above

55. When a dolphin glides through air, it experiences an external pressure of 0.75 m of mercury. The absolute pressure on dolphin when it is 5 m below the free surface of the water is

- (a) 0.10 N/mm²
- (b) 0.5 N/mm²
- (c) 1.0 N/mm²
- (d) 0.15 N/mm²

56. Which one of the following statements is correct ?

- (a) For a floating body, the stable equilibrium condition exists when position of metacentre remains higher than the centre of gravity of the body
- (b) For a floating body, the stable equilibrium condition exists when position of metacentre remains lower than the centre of gravity of the body
- (c) For a floating body, the neutral equilibrium condition exists when position of metacentre remains higher than the centre of gravity of the body
- (d) For a floating body, the unstable equilibrium condition exists when position of metacentre remains higher than the centre of gravity of the body

57. A 2-D flow field is defined as

$\vec{V} = \vec{i}x - \vec{j}y$. The equation of streamline passing through the point (1, 1) is

- (a) $xy - 1 = 0$
- (b) $xy + 1 = 0$
- (c) $xy + 2 = 0$
- (d) $xy - 2 = 0$

58. A flownet is a graphical representation of streamlines and equipotential lines such that these lines

- (a) Intersect each other at various different angles forming irregular shaped nets
- (b) Intersect each other orthogonally forming curvilinear squares
- (c) Indicate the direction but not magnitude of vector
- (d) Indicate the direction and magnitude of vector

59. Which one of the following statements is correct for the velocity potential ?

- (a) Existence of velocity potential is an indication of irrotational nature of the flow
- (b) The velocity potential automatically satisfies the continuity equation
- (c) Velocity potential can be defined only for 2-dimensional flow
- (d) All of the above

60. Angle of diverging portion of the venturi-meter is limited to 7° , because :

1. Flow decelerates in the diverging portion and pressure increases in the downstream direction. Hence, the fluid experience an adverse pressure gradient, if the divergence angle is large.

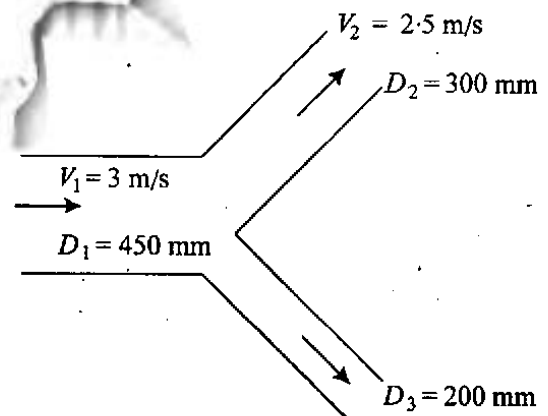
2. Flow separation takes place due to adverse pressure gradient when divergence angle is large.

3. If the divergence angle is large, a negative pressure is created at the throat which obstructs the flow of fluid.

Which of the above reasons are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

61.



In the above layout of piping, what is the velocity in 200 mm diameter pipe ?

- (a) 2.5 m/s
- (b) 5.55 m/s
- (c) 7.25 m/s
- (d) 9.56 m/s

62. Bernoulli's equation is applicable between any two points located in

- (a) Rotational flow of an incompressible fluid
- (b) Irrotational flow of compressible or incompressible fluid
- (c) Steady, rotational flow of an incompressible fluid
- (d) Steady, irrotational flow of an incompressible fluid

63. Water flows through a smooth circular pipe of diameter D and length L because of a pressure difference ΔP across the length. The volume flow rate is Q and the flow is turbulent with Reynolds number 10^5 . If the pressure difference is increased to $4 \Delta P$ the volume flow rate will be

- (a) $2Q$
- (b) A little more than $2Q$
- (c) A little less than $2Q$
- (d) $4Q$

64. When the pressure drop across a converging-diverging nozzle is different from the design value for isentropic flow, which of the following is possible?

- (a) There is one normal shock in the converging part and one normal shock in the diverging part

(b) There is only one normal shock in the converging part and none in the diverging part

(c) There is only one normal shock in the diverging part and none in the converging part

(d) There are two or more normal shocks, depending on the pressure drop, in the diverging part and none in the converging part

65. Consider the following statements pertaining to boundary layer on solid surfaces:

1. The boundary layer separation takes place if the pressure gradient is zero.

2. The condition of boundary layer separation is $\left(\frac{\partial u}{\partial y}\right)_{y=0} = 0$.

3. Boundary layer on a flat plate is laminar if the Reynolds number is less than 5×10^5 .

Which of the above statements is/are correct?

(a) 1, 2 and 3

(b) 1 and 2 only

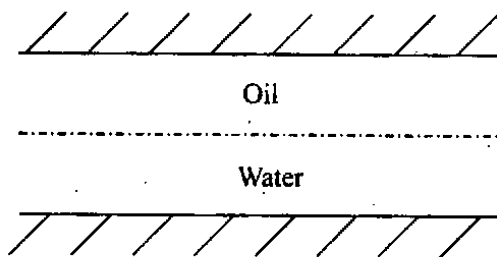
(c) 2 and 3 only

(d) 1 and 3 only

66. For laminar flow through a round pipe, the shear stress

- (a) Remains constant over the cross-section
- (b) Varies linearly with the radial distance
- (c) Must be zero at all points
- (d) Varies parabolically with radial distance

67.



Consider flow of oil and water through a channel; the boundary conditions at the interface are

- (a) Velocity and shear stress are continuous
 - (b) Shear stress is continuous and velocity is discontinuous
 - (c) Shear stress is zero and velocity is continuous
 - (d) Shear stress is zero
68. Which one of the following statements is *not* correct in the context of laminar flow through a pipeline ?
- (a) Shear stress is zero at the centre and varies linearly with pipe radius
 - (b) Head loss is proportional to square of the average flow velocity

(c) The friction factor varies inversely with flow Reynolds number

(d) No dispersion of dye injected into the flow stream

69. Laminar flow between closely spaced parallel plates is governed by the consideration of which one of the following pair of forces ?

(a) Pressure and inertial forces

(b) Gravity and inertial forces

(c) Viscous and inertial forces

(d) Pressure and viscous forces

70. Across the normal shock, fluid properties change in such a manner that the :

1. Velocity of flow is subsonic

2. Pressure increases

3. Specific volume decreases

4. Temperature decreases

Which of the above are correct ?

(a) 1, 2, 3 and 4

(b) 2, 3 and 4 only

(c) 1 and 4 only

(d) 1, 2 and 3 only

71. In a compressible flow with friction choking through a constant area duct with supersonic flow at inlet, if the pipe length is reduced with the same exit pressure

- (a) Exit flow will still be sonic
- (b) The velocity at exit is subsonic
- (c) The flow will still be supersonic
- (d) A shock will appear at the exit

72. When a converging-diverging nozzle is operated at off-design conditions, a normal shock forms in the diverging portion. The nozzle can be assumed to be perfectly insulated from the surroundings. Then across the shock

- (a) The velocity undergoes a jump but pressure and entropy remain unchanged
- (b) The pressure undergoes a jump but velocity and entropy remain unchanged
- (c) The velocity and pressure undergo a jump, but entropy remains unchanged because there is no heat transfer
- (d) Velocity, pressure and entropy all undergo a jump

73. Formation and collapse of vapour bubbles are believed to be the root cause for cavitations in hydraulic turbines. Most favourable condition for the formation of bubbles is set in the turbines at

- (a) Penstock/Nozzle
- (b) Guide vanes/Inlet of the runner
- (c) Vanes receiving impact of jet
- (d) Outlet of the runner/Entrance of the draft tube

74. For fully developed laminar flow through a circular pipe with Reynolds number Re the friction factor is

- (a) Inversely proportional to Re
- (b) Proportional to Re
- (c) Proportional to square of Re
- (d) Independent of Re

75. Choked flow through an isentropic nozzle implies :

1. Discharge is maximum
2. Discharge is zero
3. Nozzle exit pressure \leq critical pressure
4. Mach number at the throat is unity

Which of the above statements are correct ?

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 3 only
- (c) 1, 3 and 4 only
- (d) 2, 3 and 4 only

76. In a two stage gas turbine plant, with intercooling and reheating

- (a) Both work ratio and thermal efficiency increase
- (b) Work ratio increases but thermal efficiency decreases
- (c) Thermal efficiency increases but work ratio decreases
- (d) Both work ratio and thermal efficiency decrease

77. The ratio of power outlet of the pump to the power input to the pump is known as

- (a) Mechanical efficiency
- (b) Static efficiency
- (c) Overall efficiency
- (d) Manometric efficiency

78. A pump is defined as a device which converts

- (a) Hydraulic energy into mechanical energy
- (b) Mechanical energy into hydraulic energy
- (c) Kinetic energy into mechanical energy
- (d) None of the above

79. The specific speed of a pump is defined as the speed of the unit of such a size that it

- (a) Delivers unit discharge at unit head
- (b) Requires unit power to develop unit head

(c) Delivers unit discharge at unit power

(d) Produces unit power with unit head available

80. Negative slip occurs in reciprocating pumps, when delivery pipe is

- (a) Long and suction pipe is short and pump is running at low speed
- (b) Long and suction pipe is short and pump is running at high speed
- (c) Short and suction pipe is long and pump is running at low speed
- (d) Short and suction pipe is long and pump is running at high speed

81. Consider the following statements :

1. The wheel can be operated freely in air
2. Pressure at the exit of the nozzle is atmospheric
3. Pressure does not vary along the moving vanes
4. Change in direction of momentum imparts thrust over moving vanes

Which of the above statements are applied to impulse turbine ?

- (a) 1, 2 and 3 only
- (b) 1, 2 and 4 only
- (c) 3 and 4 only
- (d) 1, 2, 3 and 4

82. A water jet 0.0015 m^2 in area issues from a nozzle with 15 m/s velocity. It is made to impinge perpendicular on to a plate that moves away from the jet with a velocity of 5 m/s . The force on the plate due to this impact is

- (a) 150 N
- (b) 1470 N
- (c) 340 N
- (d) 900 N

83. Consider the following statements with regard to hydraulic turbines :

1. Kaplan turbines are most efficient at part load operations.
2. If n is the number of jets in a Pelton turbine, then the specific speed is proportional to n^2 .
3. The flow ratio of Francis turbines are in the range of $0.1 - 0.3$.

Which of the above statements is/are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

84. A converging-diverging nozzle is operated at a pressure difference which is not the design value for isentropic flow. As a consequence a normal shock is formed in the diverging portion. In this situation the Mach number at the throat is

- (a) Less than 1
- (b) More than 1
- (c) Exactly 1
- (d) Could be less or more than 1 depending on the pressure difference

85. The air pre-heater of a boiler is located between

- (a) Forced draft fan and furnace
- (b) Furnace and economizer
- (c) Economizer and chimney
- (d) Superheater and furnace

86. A super critical boiler requires

- (a) Only preheater and superheater
- (b) Preheater, evaporator and superheater
- (c) Only preheater
- (d) Only superheater

87. The correct sequence of location of equipment in the flue gas path from furnace exit up to chimney is

- (a) Superheater, economizer, air heater, electrostatic precipitator and induced draft fans
- (b) Superheater, economizer, electrostatic precipitator, induced draft fans and air heater
- (c) Superheater, electrostatic precipitator, economizer, air heater and induced draft fans
- (d) Superheater, electrostatic precipitator, induced draft fans, economizer and air heater

88. The main advantage of the water tube boiler over the fire-tube boiler is

- (a) The water tube boiler can operate safely at higher pressure
- (b) Soot deposition in the tubes is avoided
- (c) Corrosion of the tubes is less
- (d) Fouling of the tubes is reduced

89. A super critical boiler consists of only economizer and superheater and it does not have an evaporator because

- (a) Water temperature can be raised to critical temperature in the economizer itself

(b) High evaporation rate is achieved through forced circulation of water through tubes

(c) Enthalpy of evaporation becomes zero at critical pressure or above that

(d) Flue gas used to run rotary compressor supply high pressure air to the furnace

90. The effect of considering friction in steam nozzle for the same pressure ratio leads to

(a) Increase in dryness fraction of exit steam

(b) Decrease in dryness fraction of exit steam

(c) No change in the quality of exit steam

(d) Decrease or increase of dryness fraction of exit steam depending upon inlet quality

91. In a half-degree reaction Parson's turbine, operating at design conditions, the enthalpy drop of steam in one stage of the turbine occurs

(a) Entirely in the fixed blades

(b) Entirely in the moving blades

(c) Half in the fixed blades and half in the moving blades

(d) None of the above

92. The collection efficiency of cyclone separators increases with :

1. Decreasing particle size
2. Increasing particle density
3. Decreasing gas velocity
4. Increasing number of gas revolutions
5. Increasing cyclone diameter

Which of the above statements are correct ?

- (a) 1, 3 and 4 only
- (b) 2 and 4 only
- (c) 2, 4 and 5 only
- (d) 1, 2, 3, 4 and 5

93. Reheating of steam in a steam power plant :

1. Increases the cycle efficiency
2. Reduces the turbine speed
3. Reduces blade erosion
4. Increases specific output

Which of the above statements are correct ?

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 3 only
- (c) 2 and 4 only
- (d) 1, 3 and 4 only

94. Following points express the effect of keeping high clearance volume for the cylinders in reciprocating compressor. Which one of the following points is disagreeable ?

- (a) By increasing clearance volume volumetric efficiency decreases
- (b) By increasing clearance volume power consumption increases
- (c) By increasing clearance volume chances of piston striking cylinder head gets reduced
- (d) By increasing clearance volume maximum compression pressure value decreases

95. Consider the following statements :

1. Stalling is the separation of flow from the blade surface.
2. Surging leads to physical damage due to impact loads and high frequency vibration.
3. Mass flow rate is minimum if choking occurs.

Which of the above statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 3 only
- (c) 1 and 2 only
- (d) 2 and 3 only

96. Across the normal shockwave :

1. Stagnation pressure decreases whereas stagnation temperature remains constant
2. Mach number before the shockwave is always greater than one and after the shockwave, the Mach number need not be less than one
3. Across the shockwave there is a rise in pressure and temperature
4. The product of Mach number downstream of normal shockwave and upstream of normal shockwave is always one

Which of the above statements are correct ?

- (a) 1 and 3
- (b) 2 and 3
- (c) 1 and 4
- (d) 2 and 4

97. Which of the following statements are correct ?

1. Velocity compounded impulse turbine gives less speed and less efficiency.
2. For an ideal centrifugal compressor, the pressure produced depends on impeller velocity and diameter.
3. While flowing through the rotor blades in a gas turbine, the relative velocity of gas continuously decreases.
4. While flowing through the rotor blades in an axial flow compressor, the relative velocity of air continuously decreases.

(a) 1 and 3

(b) 2 and 3

(c) 1 and 4

(d) 2 and 4

98. What is the power required to drive a centrifugal air compressor, when impeller diameter is 0.45 m and N is 7200 rpm ?

(a) 28.78 kW/kg/s

(b) 30.78 kW/kg/s

(c) 27.78 kW/kg/s

(d) 26.78 kW/kg/s

99. Cooling of reciprocating compressor cylinder :

1. Increases the volumetric efficiency
2. Increases the work input
3. Decreases the volumetric efficiency
4. Decreases the work input

Which of the above statements are correct ?

(a) 1 and 2

(b) 2 and 3

(c) 3 and 4

(d) 1 and 4

100. In supersonic flow of air, a diverging passage results in

- (a) Increase in velocity and pressure
- (b) Decrease in pressure and density
- (c) Increase in velocity and density
- (d) Decrease in velocity and pressure

Directions :

Each of the next Twenty (20) items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :

Codes :

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is *not* the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

101. Statement (I) : Negative temperatures are impossible on the Kelvin scale.

Statement (II) : The Kelvin scale is thermodynamic temperature scale.

102. Statement (I) : A breeder reactor does not require moderator.

Statement (II) : The parasite absorption of neutrons is low.

103. Statement (I) : Property tables list different values of some properties for a substance at the same state as a result of using different reference states.

Statement (II) : The reference state chosen is of no consequence in thermodynamic process calculations as long as we use values from the single consistent set of tables.

104. Statement (I) : In an air-conditioned room, the reflective coating should be on the inside of the window.

Statement (II) : Window pane glass is transparent to solar radiation.

105. Statement (I) : The coefficient of discharge for a mouthpiece is higher than that of an orifice.

Statement (II) : The discharge through an orifice varies as $H^{1/2}$ whereas the discharge through a mouthpiece varies as $H^{2/3}$ (where H is the head causing the flow in both cases).

106. Statement (I) : A rocket engine can operate even in vacuum and in any fluid medium.

Statement (II) : Rocket engine is a pure reaction engine which produces propulsive thrust.

107. Statement (I) : Both pressure and temperature across the normal shock increase.

Statement (II) : The stagnation pressure across the normal shock decreases.

108. Statement (I) : When a given body floats in different liquids, the volume displaced will decrease with increase in the specific gravity of the fluid.

Statement (II) : The weight of the floating body is equal to the weight of the volume displaced.

109. Statement (I) : The vertical boilers are used to save the floor space.

Statement (II) : Horizontal boilers are more efficient than vertical boilers.

110. Statement (I) : A small insect can sit on the free surface of a liquid though insect's density is higher than that of the liquid.

Statement (II) : Liquids have viscosity.

111. Statement (I) : An SI engine requires greater spark advance at lower loads.

Statement (II) : Increased dilution by residual gases at lower loads reduces the combustion rate.

112. Statement (I) : In Boiling Water Reactor (BWR) coolant serves the triple function of coolant, moderator and working fluid.

Statement (II) : The steam flowing to the turbine is produced directly in the reactor core.

113. Statement (I) : Modern turbines have velocity compounding at the initial stages and pressure compounding in subsequent stages.

Statement (II) : Excessive tip leakage occurs in the high pressure region of reaction blading.

114. Statement (I) : In CI engines increase of load decreases the knocking tendency.

Statement (II) : Increase of load increases the temperature of mixture and thereby decrease in delay angle.

115. Statement (I) : In Impulse turbines pressure change occurs only in the nozzles of the machine. The pressure of liquid does not change while flowing through the rotor of the machine.

Statement (II) : The pressure of liquid changes while it flows through the rotor of the machine in Reaction turbine.

116. Statement (I) : The efficiency of a boiler is more if it is provided with mechanical draught rather than with natural draught.

Statement (II) : Natural draught is very costly but highly efficient.

117. Statement (I) : In common rail system, the nozzle construction must be closely matched to ensure equality of fuel discharge from cylinder to cylinder.

Statement (II) : The discharge from the nozzles is regulated by the size of orifice and pressure drop.

118. Statement (I) : The term surge indicates a phenomenon of instability which takes place at low flow values and which involves an entire system including not only the centrifugal compressor, but also the group of components traversed by the fluid upstream and downstream of it.

Statement (II) : Choking is defined as separation of fluid from the rotor blades of centrifugal compressor.

119. Statement (I) : The four stroke cycle internal combustion reciprocating engines run at higher speeds than the two stroke cycle engines.

Statement (II) : The separate exhaust and intake strokes of the four stroke cycle engines provide greater opportunity for the dissipation of heat from critical parts such as piston.

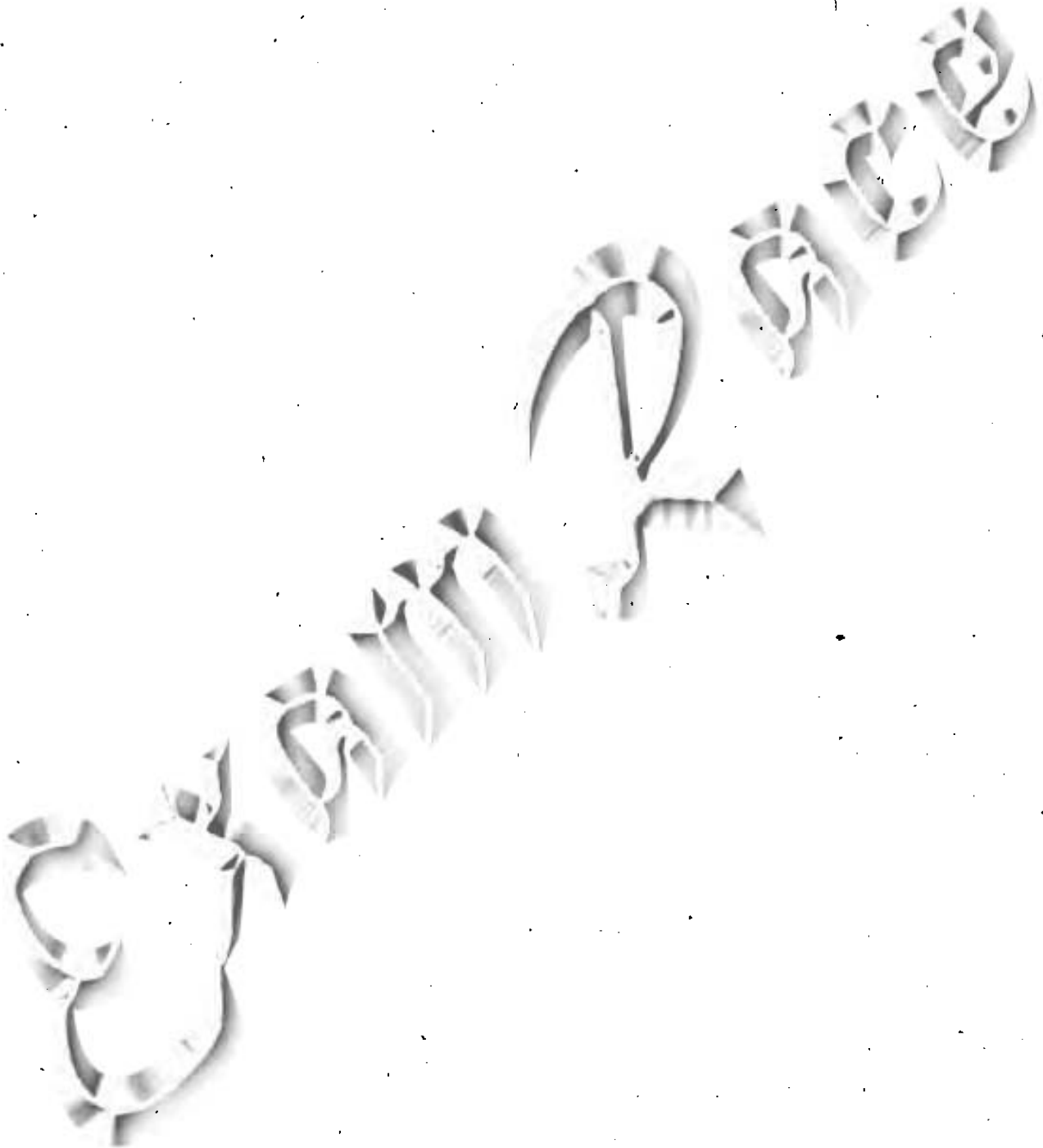
120. Statement (I) : An impulse turbine can run without change in its hydraulic efficiency even if its casing is damaged.

Statement (II) : An impulse turbine will not have draft tube.

SPACE FOR ROUGH WORK



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

T.B.C. : B-DMHH-N-NFB

Test Booklet Series

Serial No. 56441

A

**TEST BOOKLET
MECHANICAL ENGINEERING
Paper—II**

Time Allowed : Two Hours

Maximum Marks : 200

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET *DOES NOT* HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
2. Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Test Booklet Series Code A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the **OMR Answer Sheet**. Any omission/ discrepancy will render the Answer Sheet liable for rejection.
3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. *DO NOT* write *anything else* on the Test Booklet.
4. This Test Booklet contains 120 items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose *ONLY ONE* response for each item.
5. You have to mark your responses *ONLY* on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator *only the Answer Sheet*. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers :**
THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE.
 - (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to that question will be deducted as penalty.
 - (ii) If a candidate gives more than one answer, it will be treated as **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
 - (iii) If a question is left blank, i.e., no answer is given by the candidate, there will be **no penalty** for that question.

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

1. In a crank and slotted lever quick-return motion, the distance between the fixed centres is 150 mm and the length of the driving crank is 75 mm. The ratio of the time taken on the cutting and return strokes is

- (a) 1.5
- (b) 2.0
- (c) 2.2
- (d) 2.93

2. A helical coil spring of stiffness k is cut to two equal halves and then these are connected in parallel to support a vibrating mass m . The angular frequency of vibration, ω_n is

- (a) $\sqrt{\frac{k}{m}}$
- (b) $\sqrt{\frac{2k}{m}}$
- (c) $\sqrt{\frac{4k}{m}}$
- (d) $\sqrt{\frac{k}{4m}}$

3. Consider the following statements :

In a slider-crank mechanism, the slider is at its dead centre position when the

- 1. slider velocity is zero
- 2. slider velocity is maximum
- 3. slider acceleration is zero
- 4. slider acceleration is maximum

Which of the above statements are correct?

- (a) 1 and 4
- (b) 1 and 3
- (c) 2 and 3
- (d) 2 and 4

4. Which one of the following mechanisms is an inversion of double slider-crank chain?

- (a) Elliptic trammels
- (b) Beam engine
- (c) Oscillating cylinder engine
- (d) Coupling rod of a locomotive

5. The number of instantaneous centres of rotation for a 10-link kinematic chain is

- (a) 36
- (b) 90
- (c) 120
- (d) 45

6. A slider moves with uniform velocity v on a revolving link of length r with angular velocity ω . The Coriolis acceleration component of a point on the slider relative to a coincident point on the link is equal to

- (a) ωv parallel to the link
- (b) $2\omega v$ perpendicular to the link
- (c) ωv perpendicular to the link
- (d) $2\omega v$ parallel to the link

7. The governor becomes isochronous, when

- (a) $F = ar + b$
- (b) $F = ar - b$
- (c) $F = ar^2 + b$
- (d) $F = ar$

where F is controlling force, r is radius of rotation for governing balls and a, b are constants.

8. The sensitiveness of a governor is defined as

- (a) $\frac{N_1 - N_2}{N_1 + N_2}$
- (b) $\frac{N_1 + N_2}{N_1 - N_2}$
- (c) $2\left(\frac{N_1 + N_2}{N_1 - N_2}\right)$
- (d) $2\left(\frac{N_1 - N_2}{N_1 + N_2}\right)$

where N_1 and N_2 are the maximum and the minimum equilibrium speeds of the governor respectively.

9. Which of the following statements are correct for mating gears with involute profiles?

1. The pressure angle, from the start of the engagement to the end of the engagement, remains constant.
2. The pressure angle is maximum at the beginning of the engagement, reduces to zero at pitch point, starts decreasing and again becomes maximum at the end of the engagement.
3. The face and flank of the teeth are generated by a single curve and the normal to this curve at any point is tangent to the base circle of the gear.
4. The centre distance for a pair of mating gears can be varied within limits without altering the velocity ratio.

Select the correct answer using the code given below.

- (a) 1, 3 and 4
- (b) 1 and 3 only
- (c) 2 and 4 only
- (d) 2, 3 and 4

10. Two involute gears are designed to mesh for a given centre distance and a given angular velocity ratio (other than 1). During assembly, the centre distance has increased slightly. Then which of the following changes occur?

1. Velocity ratio changes
2. Pressure angle changes
3. Pitch circle diameter changes
4. Working depth changes
5. Base circle radius changes

Select the correct answer using the code given below.

- (a) 1, 2 and 3
- (b) 2, 3 and 4
- (c) 2 and 5
- (d) 3 and 5

11. In a governor, if the equilibrium speed is constant for all radii of rotation of balls, the governor is said to be

- (a) stable
- (b) unstable
- (c) inertial
- (d) isochronous

12. Critical speed is expressed as

- (a) rotation of shaft in degrees
- (b) rotation of shaft in radians
- (c) rotation of shaft in minutes
- (d) natural frequency of the shaft

13. In a locomotive, the ratio of the connecting rod length to the crank radius is kept very large in order to

- (a) minimize the effect of primary forces
- (b) minimize the effect of secondary forces
- (c) have perfect balancing
- (d) start the locomotive conveniently

14. In balancing of single-cylinder engine, the rotating unbalance is

- (a) completely made zero and so also the reciprocating unbalance
- (b) completely made zero and the reciprocating unbalance is partially reduced
- (c) partially reduced and the reciprocating unbalance is completely made zero
- (d) partially reduced and so also the reciprocating unbalance

15. The first critical speed of an automobile running on a sinusoidal road is calculated by (modelling it as a single degree of freedom system)

- (a) resonance
- (b) approximation
- (c) superposition principle
- (d) Rayleigh quotient

16. The equation of free vibration of a system is $\frac{d^2x}{dt^2} + 64\pi^2x = 0$. Its natural frequency would be

- (a) 4π Hz
- (b) 8π Hz
- (c) $64\pi^2$ Hz
- (d) 4 Hz

17. Linear vibration analysis has the greatest advantage because of

- (a) Newton's laws of motion
- (b) eigenvalue analysis
- (c) Rayleigh quotient
- (d) principle of superposition

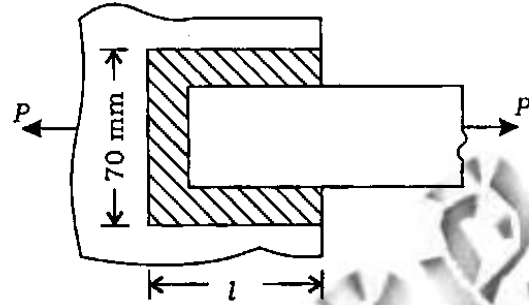
18. Which of the following are responsible for occurrence of critical or whirling speed of shaft?

1. Eccentric mounting of the rotor
2. Non-uniform distribution of rotor material
3. Bending of shaft due to the weight of the rotor and the shaft itself
4. Environmental effect such as effect of moisture and temperature

Select the correct answer using the code given below.

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 3 only
- (c) 1, 2 and 4 only
- (d) 1 and 3 only

19. Two plates are jointed as shown in the figure



The maximum tensile and shear stresses are 70 N/mm^2 and 56 N/mm^2 respectively. The plate is 70 mm wide and 12.5 mm thick. What will be the value of l if the total load carried by the joint is 85 kN?

- (a) 126.39 mm
- (b) 84.25 mm
- (c) 70.00 mm
- (d) 42.125 mm

20. If a rectangular key of 8 mm width and 6 mm height and a shaft of diameter 32 mm are made of same material, then the necessary length of the key for equal shear strength of shaft and key will be (neglecting stress concentration on the shaft)

- (a) 50.24 mm
- (b) 55 mm
- (c) 45 mm
- (d) 60.24 mm

21. Rivets undergo single shear in

- (a) lap joint and single-cover butt joint
- (b) single-cover butt joint and double-cover butt joint
- (c) lap joint and double-cover butt joint
- (d) lap joint only

22. A multi-disc clutch employs 3 steel and 2 bronze discs having outer diameter of 300 mm and inner diameter of 175 mm. If the coefficient of friction is 0.25 and axial force on each pair of surfaces is 5 kN, then the torque transmitted (assuming uniform wear) is

- (a) 416.6 N m
- (b) 887.5 N m
- (c) 1093.75 N m
- (d) 593.75 N m

23. A truncated conical pivot bearing has semi-cone angle α and the two radii are r_1 and r_2 respectively with $r_1 > r_2$. The coefficient of friction between the sliding surfaces is μ . For an axial thrust load of W kN, the reduction in torque due to friction (assuming uniform rate of wear) is

- (a) $\mu W(r_1 + r_2) \operatorname{cosec} \alpha$
- (b) $\frac{1}{2} \mu W(r_1 + r_2) \operatorname{cosec} \alpha$
- (c) $\frac{3}{2} \mu W \left[\frac{(r_1)^3 - (r_2)^3}{3} \right] \operatorname{cosec} \alpha$
- (d) $\frac{2}{3} \mu W \left[\frac{(r_1)^3 - (r_2)^3}{3} \right] \operatorname{cosec} \alpha$

24. Which of the following statements are correct regarding power transmission through V-belts?

1. V-belts are used at the high-speed end.
2. V-belts are used at the low-speed end.
3. V-belts are of standard lengths.
4. V-angles of pulleys and belts are standardized.

Select the correct answer using the code given below.

- (a) 1 and 3 only
- (b) 2 and 4 only
- (c) 2, 3 and 4
- (d) 1, 3 and 4

25. Pressure angle of involute gears does not exceed 25° , since

- (a) this will lead to unwanted radial force
- (b) the number of teeth to avoid undercutting will be very high
- (c) no cutters are available
- (d) gears will become too small

26. Consider the following statements :

In the case of involute gears in contact

1. the motion is one of pure rolling
2. pressure angle does not change during contact
3. velocity ratio does not change
4. output torque of the driven gear changes

Which of the above statements are correct?

- (a) 1 and 2
- (b) 2 and 4
- (c) 2 and 3
- (d) 3 and 4

27. If the centre distance between a pair of spur gears in mesh is 240 mm and the pinion moves five times faster than the gear, then the pitch circle diameters of pinion and gear respectively are

- (a) 40 mm and 200 mm
- (b) 80 mm and 400 mm
- (c) 60 mm and 300 mm
- (d) 50 mm and 250 mm

28. The diameter of a solid shaft made of mild steel, rotating at 250 r.p.m. is 45 mm. The shaft is designed to transmit 50 kW. What will be the factor of safety if the ultimate shear stress at yield is 427 N/mm^2 ?

- (a) 6
- (b) 5
- (c) 4
- (d) 3

29. The bending moment (M) and twisting moment (T) at four particular sections P , Q , R and S along the length of a shaft are as follows :

Section	P	Q	R	S
M (N m)	10	40	20	15
T (N m)	45	30	50	40

Which section is to be considered for designing the shaft?

- (a) P
- (b) Q
- (c) R
- (d) S

30. If T_1 and m represent the maximum tension and mass per unit length of a belt, then the maximum permissible speed of the belt is given by

(a) $\sqrt{\frac{T_1}{3m}}$ (b) $\sqrt{\frac{3T_1}{m}}$

(c) $\sqrt{\frac{2T_1}{3m}}$ (d) $\sqrt{\frac{T_1}{m}}$

31. The efficiency of a power screw is maximum, when the lead (helix) angle is

(a) $\frac{\pi}{2} - \frac{\Phi}{2}$

(b) $\frac{\pi}{2} - \Phi$

(c) $\frac{\pi}{4} - \frac{\Phi}{2}$

(d) $\frac{\pi}{4} - \Phi$

where Φ is friction angle.

32. Consider that a wire rope is subjected to the following stresses :

1. Direct stress on account of axial force
2. Bending stress
3. Stress due to acceleration of the moving mass

Which of the above are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

33. When a shaft rotates in anti-clockwise direction at high speed in a bearing, it will

(a) move towards right of the bearing making metal to metal contact

(b) have contact at the lowest point of the bearing

(c) move towards left of the bearing making metal to metal contact

(d) move towards left of the bearing making no metal to metal contact

34. The load on a gear tooth is 50 kN. If the gear is transmitting a torque of 6000 N m, the diameter of the gear is approximately (consider pressure angle as 20° and $\cos 20^\circ = 0.94$)

(a) 0.5 m

(b) 0.75 m

(c) 1 m

(d) 0.25 m

35. In a particular application, the shaft is subjected to bending loads and also large axial loads. The bearing suitable for supporting such a shaft is

(a) thrust bearing

(b) tapered roller bearing

(c) ball bearing

(d) spherical roller bearing

36. A hole of diameter 35 mm is to be punched in a sheet metal of thickness t and ultimate shear strength 400 MPa, using punching force of 44 kN. The maximum value of t is

- (a) 0.5 mm
- (b) 10 mm
- (c) 1 mm
- (d) 2 mm

37. Two principal tensile stresses of magnitudes 40 MPa and 20 MPa are acting at a point across two perpendicular planes. An oblique plane makes an angle of 30° with the major principal plane. The normal stress on the oblique plane is

- (a) 8.66 MPa
- (b) 17.32 MPa
- (c) 35.0 MPa
- (d) 60.0 MPa

38. The state of stress at a point under plane stress condition is

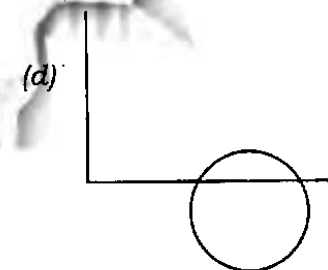
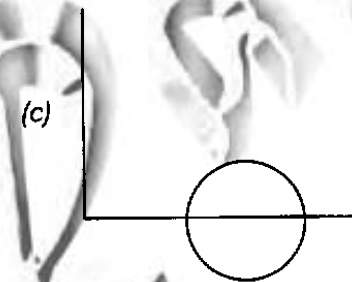
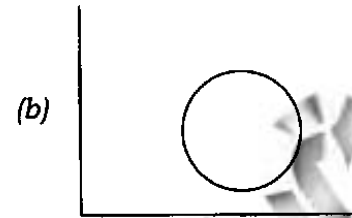
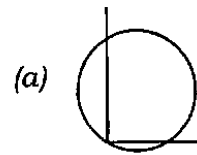
$$\sigma_{xx} = 60 \text{ MPa}, \sigma_{yy} = 120 \text{ MPa}$$

$$\text{and } \tau_{xy} = 40 \text{ MPa}$$

The radius of Mohr's circle representing the given state of stress in MPa is

- (a) 40
- (b) 50
- (c) 60
- (d) 120

39. Which of the following figures may represent Mohr's circle?



40. If Mohr's circle is drawn for the shear stress developed because of torque applied over a shaft, then the maximum shear stress developed will be equal to

- (a) diameter of the Mohr's circle
- (b) radius of the Mohr's circle
- (c) half of the radius of the Mohr's circle
- (d) 1.414 times radius of the Mohr's circle

41. The modulus of rigidity and the bulk modulus of a material are found as 70 GPa and 150 GPa respectively. Then

1. elasticity modulus is 200 GPa
2. Poisson's ratio is 0.22
3. elasticity modulus is 182 GPa
4. Poisson's ratio is 0.3

Which of the above statements are correct?

- (a) 1 and 2
- (b) 1 and 4
- (c) 2 and 3
- (d) 3 and 4

42. Consider the following statements :

1. Cross-section of a member of truss, experiences uniform stress.
2. Cross-section of a beam experiences minimum stress.
3. Cross-section of a beam experiences linearly varying stress.
4. Cross-sections of truss members experience only compressive stress.

Which of the above statements are correct?

- (a) 1 and 2
- (b) 1 and 3
- (c) 1 and 4
- (d) 3 and 4

43. A steel rod, 2 m long, is held between two walls and heated from 20 °C to 60 °C. Young's modulus and coefficient of linear expansion of the rod material are 200×10^3 MPa and $10 \times 10^{-6} / ^\circ\text{C}$ respectively. The stress induced in the rod, if walls yield by 0.2 mm, is

- (a) 60 MPa tensile
- (b) 80 MPa tensile
- (c) 80 MPa compressive
- (d) 60 MPa compressive

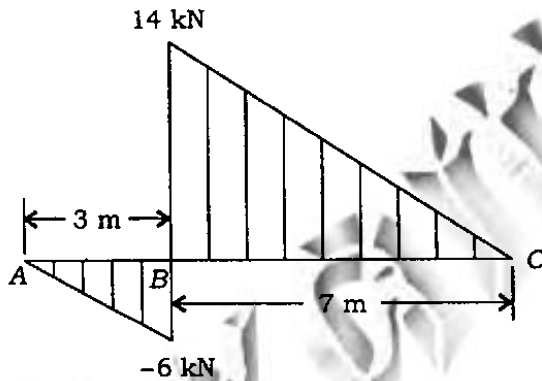
44. A tension member of square cross-section of side 10 mm and Young's modulus E is to be replaced by another member of square cross-section of same length but Young's modulus $E/2$. The side of the new square cross-section, required to maintain the same elongation under the same load, is nearly

- (a) 14 mm
- (b) 17 mm
- (c) 8 mm
- (d) 5 mm

45. An aluminium bar of 8 m length and a steel bar of 5 mm longer in length are kept at 30 °C. If the ambient temperature is raised gradually, at what temperature the aluminium bar will elongate 5 mm longer than the steel bar (the linear expansion coefficients for steel and aluminium are $12 \times 10^{-6} / ^\circ\text{C}$ and $23 \times 10^{-6} / ^\circ\text{C}$ respectively)?

- (a) 50.7 °C
- (b) 69.0 °C
- (c) 143.7 °C
- (d) 33.7 °C

46. The part of the shear force diagram for a beam is shown in the figure



If the bending moment at B is -9 kN m, then the bending moment at C is

- (a) 40 kN m
- (b) 58 kN m
- (c) 116 kN m
- (d) -80 kN m

47. A beam of length L and flexural rigidity EI is simply supported at the ends and carries a concentrated load W at the middle of the span. Another beam of identical length L and flexural rigidity EI is fixed horizontally at both ends and carries an identical concentrated load W at the mid-span. The ratio of central deflection of the first beam to that of the second beam is

- (a) 1
- (b) 2
- (c) 0.25
- (d) 4

48. A bar of rectangular cross-section ($b \times 2b$) and another bar of circular cross-section (diameter = d) with the same length, are made of same material, and are subjected to same bending moment and have the same maximum bending stress developed. The ratio of weights of rectangular bar and circular bar will be

- (a) $\frac{(2\pi)^{1/3}}{3\pi}$
- (b) $\sqrt{\pi}$
- (c) $\sqrt{3\pi}$
- (d) $\frac{(3)^{2/3}}{2(\pi)^{1/3}}$

49. A shaft of diameter 8 cm is subjected to a bending moment of 3000 N m and a twisting moment of 4000 N m. The maximum normal stress induced in the shaft is equal to

(a) $\frac{250}{\pi}$ MPa

(b) $\frac{500}{\pi}$ MPa

(c) $\frac{157.5}{\pi}$ MPa

(d) $\frac{315}{\pi}$ MPa

50. A close-coiled helical spring of 10 active turns is made of 8 mm diameter steel wire. The mean coil diameter is 10 cm. If $G = 80$ GPa for the material of spring, the extension of spring under a tensile load of 200 N will be nearly

(a) 40 mm

(b) 45 mm

(c) 49 mm

(d) 53 mm

51. Two concentric springs, having same number of turns and free axial length, are made of same material. One spring has mean coil diameter of 12 cm and its wire diameter is 1.0 cm. The other one has mean coil diameter of 8 cm and wire diameter of 0.6 cm. If the set of springs is compressed by an axial load of 2000 N, the loads shared by the springs will be

(a) 1245.5 N and 754.5 N

(b) 1391.4 N and 608.6 N

(c) 1100.0 N and 900.0 N

(d) 1472.8 N and 527.2 N

52. A rod of length l tapers uniformly from a diameter D at one end to a diameter $D/2$ at the other end and is subjected to an axial load P . A second rod of length l and of uniform diameter D is subjected to the same axial load P . Both the rods are of same material with Young's modulus of elasticity E . The ratio of extension of the first rod to that of the second rod is

(a) 4

(b) 3

(c) 2

(d) 1

53. If a thin-walled cylinder with closed hemispherical ends with thickness 12 mm and inside diameter of 1250 mm is to withstand a pressure of 1.5 MPa, then the maximum shear stress induced is

- (a) 19.5 MPa
- (b) 39.05 MPa
- (c) 78.12 MPa
- (d) 90.5 MPa

54. A 4 m long solid round bar is used as a column having one end fixed and the other end free. If Euler's critical load on this column is found as 10 kN and $E = 210$ GPa for the material of the bar, the diameter of the bar is

- (a) 50 mm
- (b) 40 mm
- (c) 60 mm
- (d) 45 mm

55. What is the slenderness ratio of a 4 m column with fixed ends if its cross-section is square of side 40 mm?

- (a) 100
- (b) 50
- (c) 160
- (d) 173

56. A cantilever beam, 2 m in length, is subjected to a uniformly distributed load of 5 kN/m. If $E = 200$ GPa and $I = 1000$ cm⁴, the strain energy stored in the beam will be

- (a) 7 N m
- (b) 12 N m
- (c) 8 N m
- (d) 10 N m

57. Consider the following statements in connection with the phase diagrams :

1. Phase diagrams of binary alloys change by the presence of other alloying elements.
2. Tie-line construction and lever rule are used to determine the phase compositions.
3. Time-temperature transformations can be studied with the help of phase diagrams.

Which of the above statements are correct?

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

58. Eutectoid reaction occurring at 727°C with 0.77% C is

- (a) austenite \rightarrow ferrite + pearlite
- (b) austenite \rightarrow ferrite + martensite
- (c) austenite \rightarrow ferrite + cementite
- (d) austenite \rightarrow martensite + bainite

59. Cast iron possessing which one of the following metallographic structures is best suited for damping capacity in engineering applications?

- (a) Excess cementite
- (b) Carbon in temper form
- (c) Silicon carbide in flake structure
- (d) Spheroidal form of graphite

60. Jominy end-quench test is carried out to determine

- (a) recrystallization temperature of steel
- (b) glass transition temperature of a material
- (c) hardenability of steel
- (d) hardness of steel

61. Consider the following statements in connection with thermoplastics :

1. They are long-chain molecules held together by van der Waals' forces.
2. They cannot be resoftened once they have set and hardened.
3. They are highly plastic and are easy for shaping.
4. Some commercial thermoplastics are polyethylene, polystyrene and PVC.

Which of the above statements are correct?

- (a) 1, 2 and 3 only
- (b) 1, 3 and 4 only
- (c) 2, 3 and 4 only
- (d) 1, 2, 3 and 4

62. Consider the following statements :

Machine tool beds are made using grey cast iron due to

1. high tensile strength and ductility
2. high compressive strength and damping property
3. castability and low cost of production
4. machinability and low material cost

Which of the above statements are correct?

- (a) 1, 2 and 3 only
- (b) 1, 3 and 4 only
- (c) 2, 3 and 4 only
- (d) 1, 2, 3 and 4

63. In hot die forging, thin layer of material all around the forging is

- (a) gutter space, which fills up hot gases
- (b) flash, the width of it is an indicator of the pressure developed in the cavity
- (c) coining, which indicates the quality of the forging
- (d) cavity, which is filled with hot impurities in the material

64. Which drill is good for inverted drilling operation?

- (a) Oil-hole drill
- (b) Straight-flute drill
- (c) Taper-shank drill
- (d) High-helix drill

65. In wire-drawing operation, the maximum reduction per pass for perfectly plastic material in ideal condition is

- (a) 68%
- (b) 63%
- (c) 58%
- (d) 50%

66. In the process of metal rolling operation, along the arc of contact in the roll gap there is a point called the neutral point, because

(a) on one side of this point, the work material is in tension and on the other side, the work material is in compression

(b) on one side of this point, the work material has velocity greater than that of the roll and on the other side, it has velocity lesser than that of the roll

(c) on one side of this point, the work material has rough surface finish and on the other side, the work material has very fine finish

(d) at this point there is no increase in material width, but on either side of neutral point, the material width increases

67. The process of impregnation in powder metallurgy technique is best described by which of the following?

(a) After sintering operation of powder metallurgy, rapid cooling is performed to avoid thermal stresses

(b) Low melting point metal is filled in the pores of a sintered powder metallurgy product

(c) Liquid oil or grease is filled in the pores of a sintered powder metallurgy product

(d) During sintering operation of powder metallurgy, rapid heating is performed to avoid sudden produce of high internal pressure due to volatilization of lubricant

68. Consider the following statements for an induction furnace :

1. High-frequency current is generally used for the furnace working.

2. There is less loss of alloying elements due to oxidation.

3. Pronounced stirring action of molten metal occurs inside the furnace.

4. Slag cover is essential for the efficient working of the furnace.

Which of the above statements are correct?

(a) 1, 3 and 4 only

(b) 2, 3 and 4 only

(c) 1, 2 and 3 only

(d) 1, 2, 3 and 4

69. The proportion of acetylene and oxygen used in gas welding is

(a) 2 : 1

(b) 1 : 1

(c) 1 : 2

(d) 3 : 4

70. In liquid-state welding process, the zones formed are

(a) gas-shielded zone, fusion zone and unaffected original base metal zone

(b) liquid zone, fusion zone and heat-affected unmelted zone

(c) liquid-shielded zone, gas-shielded zone and flux-metal reactive zone

(d) fusion zone, heat-affected unmelted zone and unaffected original base metal zone

71. A simple turning operation is carried out on a lathe machine at constant spindle speed. What will happen after a few turning passes?

- (a) Cutting velocity will increase and surface finish improves
- (b) Cutting velocity will decrease and surface finish deteriorates
- (c) Cutting velocity will increase and chattering occurs
- (d) Cutting velocity will decrease and chattering reduces

72. A milling cutter having 8 teeth is rotating at 150 r.p.m. If the feed per tooth is 0.1 mm, the table speed in mm per minute is

- (a) 70
- (b) 120
- (c) 125
- (d) 187

73. Consider the following statements regarding milling machine :

1. In the vertical milling machine, it is possible to machine dovetail recesses.
2. In universal milling machine, the worktable can be swivelled.
3. In rotary milling machine, motion imparted to work is rotary.
4. Planer milling machine is provided with several horizontal and vertical heads.

Which of the above statements are correct?

- (a) 1, 2 and 3
- (b) 1, 3 and 4
- (c) 1, 2 and 4
- (d) 2, 3 and 4

74. In a plunge grinding operation, the workpiece is 10 mm wide, the wheel is of 20 cm diameter and 2 cm wide. The wheel speed is 3000 r.p.m. and the table speed is 2.5 m/min. If the depth of cut is 0.02 mm, grain density is $250/\text{cm}^2$ and the grinding forces are 20 N tangential and 38 N thrust, the specific energy is

- (a) $75.4 \times 10^4 \text{ N/mm}^2$
- (b) $7.54 \times 10^4 \text{ N/mm}^2$
- (c) $75.4 \times 10^6 \text{ N/mm}^2$
- (d) $7.54 \times 10^6 \text{ N/mm}^2$

75. Consider the following statements with reference to grinding wheel characteristics :

1. Aluminium oxide and silicon carbide are used for making the grinding wheels.
2. Rubber bonds are used for making flexible wheels.
3. The grade of a wheel is determined by the strength of the bonding materials.
4. Negative rake angles are used for grinding of high-strength materials.

Which of the above statements are correct?

- (a) 1, 2 and 3
- (b) 1, 2 and 4
- (c) 1, 3 and 4
- (d) 2, 3 and 4

76. In NC machines, slides are positioned by hydraulic ram and are influenced by

- (a) length of stroke and mass to be displaced
- (b) feed and spindle speed
- (c) length of stroke and feed
- (d) spindle speed and mass to be displaced

77. Which one of the following statements is correct about an oblique cutting?

- (a) Direction of chip flow velocity is normal to the cutting edge of the tool
- (b) Only two components of cutting forces act on the tool
- (c) Cutting edge of the tool is inclined at an acute angle to the direction of tool feed
- (d) Cutting edge clears the width of the workpiece

78. A toothpaste tube can be produced by

- (a) solid forward extrusion
- (b) solid backward extrusion
- (c) hollow backward extrusion
- (d) hollow forward extrusion

79. The fatigue failure of a tool is due to

- (a) abrasive friction, cutting fluid and chip breakage
- (b) variable thermal stresses, chip breakage and variable dimensions of cut
- (c) abrasive friction, chip breakage and variable dimensions of cut
- (d) chip breakage, variable thermal stresses and cutting fluid

80. In accelerated tool life tests, the three main types of quick and less costly tool life testing are

- (a) extrapolation on the basis of steady wear; conventional measurement of flank and crater wear; comparative performance against tool chipping
- (b) measurement of abrasive wear; multi-pass turning; conventional measurement of diffusion wear
- (c) extrapolation on the basis of steady wear; multi-pass turning; taper turning
- (d) comparative performance against tool chipping; taper turning; measurement of abrasive wear

81. In an orthogonal turning process, the chip thickness = 0.32 mm, feed = 0.2 mm/rev. Then the cutting ratio will be

- (a) 2.6
- (b) 3.2
- (c) 1.6
- (d) 1.8

82. In an orthogonal cutting operation, shear angle = 11.31° , cutting force = 900 N and thrust force = 810 N. Then the shear force will be approximately (given $\sin 11.31^\circ = 0.2$)

- (a) 650 N
- (b) 720 N
- (c) 620 N
- (d) 680 N

83. The stick-slip motion is found to occur in machine tool slides under certain conditions which are

- (a) at very high feed rates and/or when there is small difference between the coefficients of static and dynamic friction at the slider and guideway interfaces
- (b) at very high feed rates and when there is small difference between the coefficients of static and dynamic friction at the headstock spindle and bed of machine tool

(c) at very low feed rates and/or when there is large difference between the coefficients of static and dynamic friction at the slider and guideway interfaces

(d) at very low feed rates and large difference in coefficient of only dynamic friction at headstock spindle and bed of machine tool

84. Consider the following reasons for using non-conventional machining processes :

1. High-strength alloys
2. Complex surfaces
3. High accuracies and surface finish

Which of the above are correct?

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

85. Exponential smoothing methods are best suited under conditions when

- (a) forecasting horizon is relatively large
- (b) forecasting for large number of items
- (c) available outside information is more
- (d) All of the above

86. The correct sequence of increasing production volume is
- (a) batch, job, flow and mass
 - (b) mass, flow, batch and job
 - (c) job, flow, mass and batch
 - (d) job, batch, mass and flow
87. The data for break-even analysis of a product are given as—fixed cost is ₹ 10,000; variable cost is ₹ 10/unit; selling price is ₹ 15/unit. The break-even volume is
- (a) 2000
 - (b) 2500
 - (c) 3500
 - (d) 4000
88. Bushes are generally provided in a jig to
- (a) locate the job
 - (b) guide the tool
 - (c) hold the job
 - (d) All of the above
89. In ABC inventory control of spare parts, the items A, B and C respectively refer to
- (a) high stock-out cost, moderate stock-out cost and low stock-out cost
 - (b) low stock-out cost, moderate stock-out cost and high stock-out cost
 - (c) moderate stock-out cost, high stock-out cost and low stock-out cost
 - (d) stock-out costs whose sequence depends on other factors also
90. Materials requirement planning is driven by
- (a) master production schedule
 - (b) total quality measurement
 - (c) overall production planning
 - (d) overall inventory planning
91. A microprogrammed control unit
- (a) is faster than hardwired control unit
 - (b) facilitates easy implementation of new instructions
 - (c) is useful when very small programs are to be run
 - (d) usually refers to the control unit of microprocessor
92. Preparing a magnetic disk for data storage is called
- (a) booting
 - (b) formatting
 - (c) debuffing
 - (d) buffing
93. The time for which a piece of equipment operates is called
- (a) seek time
 - (b) effective time
 - (c) access time
 - (d) real time

94. The addressing mode used in the instruction PUSH B is

- (a) direct
- (b) register
- (c) register indirect
- (d) immediate

95. Index register in a microprocessor is used for

- (a) direct addressing
- (b) address modification
- (c) pointing to the stack
- (d) loop execution

96. In the FORTRAN program

```
M = 0
DO 100 I = 1, 2
DO 200 J = 1, 2
M = M + I + J
200 CONTINUE
100 CONTINUE
STOP
END
```

the value of M in the end will be

- (a) 10
- (b) 11
- (c) 12
- (d) 14

97. In a FORTRAN program

- (a) all statements must be numbered
- (b) the numbered statements must be referred
- (c) the statements referred must be numbered
- (d) all statements must be referred

98. In C language, i^{++} means

- (a) $i = i + 1$
- (b) $i = i - 1$
- (c) $i = i + 2$
- (d) $i = i - 2$

99. Which header file should be included to use functions like malloc() and calloc()?

- (a) dos.h
- (b) stdlib.h
- (c) memory.h
- (d) string.h

100. Program status word (PSW) contains various status of

- (a) program
- (b) CPU
- (c) ALU
- (d) register

Directions :

Each of the following **twenty (20)** items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the code given below.

Code :

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is **not** the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

101. Statement (I) :

When a flat-faced follower is used, it would be preferable to provide an offset in the plane perpendicular to the plane of rotation of the cam.

Statement (II) :

Because of the offset, the follower is made to rotate continuously about its axis which in turn avoids jamming of the follower in its guide while moving up or down, reduces the wear of the follower flat surface and distributes the wear uniformly.

102. Statement (I) :

In case of partial balancing of locomotives, the maximum magnitude of the unbalanced force perpendicular to the line of stroke is called hammer blow and this has to be limited by proper choice of the balancing mass and its radial position.

Statement (II) :

The effect of hammer blow is to cause variation in pressure between the wheel and the rail, and it may sometimes cause the lifting of wheels from the rails.

103. Statement (I) :

In interference fit, the outer diameter of the inner cylinder will be more than the inner diameter of the hollow outer cylinder.

Statement (II) :

These fits are recommended for two parts frequently dismantled and assembled.

104. Statement (I) :

In short open-belt drives, an idler pulley is used in order to increase the angle of contact on the smaller pulley for higher power transmission.

Statement (II) :

The idler pulley facilitates changing the speed of the driven shaft, while the main or driving shaft runs at constant speed.

105. Statement (I) :

Worm and worm wheel drive can be reversible.

Statement (II) :

If the friction angle is more than the lead angle, the drive will be reversible.

106. Statement (I) :

In die casting process, molten metal is injected at high pressure into a metallic die.

Statement (II) :

In this die casting process, some excess metal as required than filling the mold is also forced into the parting plane.

107. Statement (I) :

I-sections are best suited for carrying bending load in one lateral direction.

Statement (II) :

In the zone, in the vicinity of neutral axis of I-beams, I-section has the least material.

108. Statement (I) :

Cast iron is good in compression.

Statement (II) :

It is extensively used in members of the truss.

109. Statement (I) :

Cobalt exhibits hexagonal close-packed structure below 420 °C.

Statement (II) :

Structure of cobalt changes to face-centred cubic structure above 420 °C.

110. Statement (I) :

Melting point of alloy containing 62% tin and 38% lead is 327 °C.

Statement (II) :

Low melting point of this alloy enables delicate parts of metal to be soldered.

111. Statement (I) :

Salts like sodium chloride, sodium hydroxide when added to water to use as quenching media, cooling rate of quenching media will be increased.

Statement (II) :

When salts are added to water, during quenching, distortion and crack appearance in the quenched steel components reduces.

112. Statement (I) :

In drawing process, cross-section of round wire is reduced by pulling it through a die.

Statement (II) :

Bundle drawing produces wires that are polygonal in cross-section rather than round.

113. Statement (I) :

For high extrusion pressure, the initial temperature of billet should be high.

Statement (II) :

As the speed of hot extrusion is increased, it may lead to melting of alloy constituents.

114. Statement (I) :

For casting of metal like magnesium, top gating is not used.

Statement (II) :

The gases will escape resulting in early cooling of metal.

115. Statement (I) :

Cupola is used in cast iron foundry.

Statement (II) :

Basic furnaces are used for melting low-grade steel.

116. Statement (I) :

In powder cutting process, iron powder is injected into the oxygen jet while the cutting is proceeding.

Statement (II) :

In this process of powder cutting, iron gets oxidized by the oxygen jet and produces additional heat for preheating of metal.

117. Statement (I) :

In sand molding process, pouring time depends on materials being cast, complexity of casting, section thickness and size.

Statement (II) :

In order to maintain optimum pouring time, thickness of casting is the important factor.

118. Statement (I) :

The length of the oxidizing flame is smallest compared to neutral or reducing flame.

Statement (II) :

Due to extra oxygen available, the combustion is faster producing smaller length of flame.

119. Statement (I) :

Lead screw is used instead of the feed rod to produce sufficiently accurate threads.

Statement (II) :

Lead screw provides more accurate movement to the carriage.

120. Statement (I) :

In the manufacture of gears by extrusion, the outside surface of the material is hard and smooth.

Statement (II) :

The material in this process passes through one hot and smooth die.

SPACE FOR ROUGH WORK



SPACE FOR ROUGH WORK



SPACE FOR ROUGH WORK