

ENGINEERING SERVICES  
EXAMINATION-2014

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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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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 (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  $377^{\circ}\text{C}$  and  $27^{\circ}\text{C}$  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  $260^{\circ}\text{C}$  and  $60^{\circ}\text{C}$ . To improve the performance, we have to

- (a) Raise the source temperature to  $300^{\circ}\text{C}$
- (b) Lower the sink temperature to  $30^{\circ}\text{C}$
- (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 :

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

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  $37^\circ\text{C}$  and  $347^\circ\text{C}$ . 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  $227^\circ\text{C}$ . The available energy added to the system, if the temperature of the surroundings is  $27^\circ\text{C}$ , 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  $-10^{\circ}\text{C}$  in the refrigerator which is kept in a room where the surrounding temperature is  $25^{\circ}\text{C}$  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  $127^{\circ}\text{C}$ . 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  $0.2 \text{ kW/mK}$  has its inner and outer surface temperatures  $600^\circ\text{C}$  and  $200^\circ\text{C}$  respectively. If the heat flux through the wall is  $200 \text{ kW/m}^2$ , 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
- The length of the cylinder
  - The diameter of the cylinder
  - The perimeter of the cylinder
  - The radius of the cylinder
34. For which of these configurations is a minimum temperature difference required for natural convection to set in
- Fluid near a heated vertical plate
  - Fluid near a heated plate inclined at  $45^\circ$  to the vertical
  - Fluid over a heated horizontal plate
  - 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  $2 \text{ kg/s}$  and the exhaust gases ( $c = 1000 \text{ J/kg K}$ ) flow at the rate of  $5 \text{ kg/s}$ . If the heat transfer surface area is  $32 \text{ m}^2$  and the overall heat transfer coefficient is  $200 \text{ W/m}^2\text{K}$ , the NTU of the heat exchanger is
- 4.5
  - 2.4
  - 8.6
  - 1.28
36. In a two-fluid heat exchanger, the inlet and outlet temperatures of the hot fluid are  $65^\circ\text{C}$  and  $40^\circ\text{C}$  respectively. For the cold fluid, these are  $15^\circ\text{C}$  and  $43^\circ\text{C}$ . The heat exchanger is a
- Parallel flow heat exchanger
  - Counter flow heat exchanger
  - Mixed flow heat exchanger
  - Phase-change heat exchanger
37. In a double-pipe heat exchanger, the cold fluid is water with inlet temperature  $20^\circ\text{C}$  and mass flow rate  $20 \text{ kg/s}$  and the hot fluid water inlet temperature  $80^\circ\text{C}$  and mass flow rate  $10 \text{ kg/s}$ . 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?
- $80^\circ\text{C}$  in both parallel flow and counter flow
  - $50^\circ\text{C}$  in both parallel flow and counter flow
  - $40^\circ\text{C}$  in parallel flow and  $50^\circ\text{C}$  in counter flow
  - $40^\circ\text{C}$  in parallel flow and  $80^\circ\text{C}$  in counter flow



38. If a body is at 2000 K, the wavelength at which the body emits maximum amount of radiation is
- 1.45  $\mu\text{m}$
  - 1.45 cm
  - 0.345 cm
  - 0.345  $\mu\text{m}$
39. An isothermal cubical ( $10\text{ m} \times 10\text{ m} \times 10\text{ m}$ ) blackbody at  $200^\circ\text{C}$  is suspended in air. The total radiation emitted by this body to its surroundings will be
- 1702.9 kW
  - 1800.7 kW
  - 54.4 kW
  - 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
- 2782 W
  - 0.139 W
  - 1392 W
  - 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
- 0.5
  - 1
  - 0
  - 0.32
42. In a vapour compression refrigeration system, the high pressure liquid from the condenser/receiver is cooled below its saturation temperature to
- Reduce the net work per cycle
  - Reduce the net refrigerating effect
  - Increase the net refrigerating effect
  - Reduce the pressure on the high pressure side
43. Specific humidity is defined as Mass of
- Water vapour contained in air-vapour mixture per kg of dry air
  - Water vapour contained per kg of air-vapour mixture
  - Dry air contained per kg of air-vapour mixture
  - 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

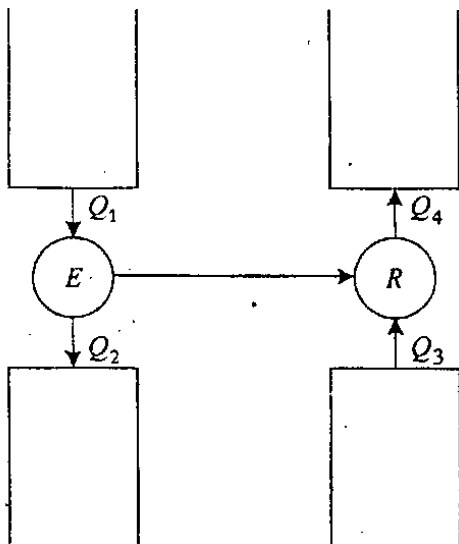
At outlet to compressor : 1800 kJ/kg

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  $-23^\circ\text{C}$  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/m<sup>2</sup> 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/mm<sup>2</sup>
- (b) 0.5 N/mm<sup>2</sup>
- (c) 1.0 N/mm<sup>2</sup>
- (d) 0.15 N/mm<sup>2</sup>

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  $7^\circ$ , 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.

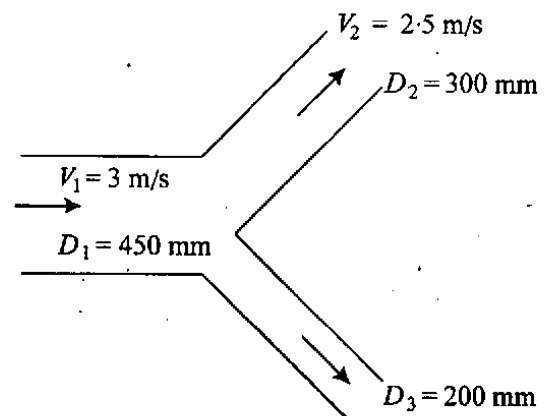
2. Flow separation takes place due to adverse pressure gradient when divergence angle is large.

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  $\Delta P$  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  $5 \times 10^5$ .

Which of the above statements is/are correct?

(a) 1, 2 and 3

(b) 1 and 2 only

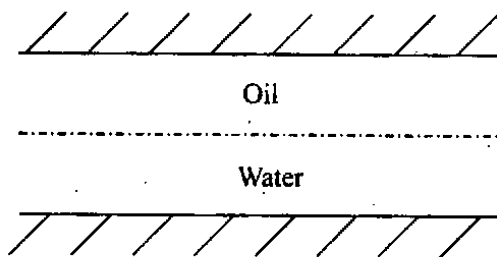
(c) 2 and 3 only

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

- (a)  $150 \text{ N}$
- (b)  $1470 \text{ N}$
- (c)  $340 \text{ N}$
- (d)  $900 \text{ N}$

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.



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