MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR
PRINCIPAL, GOVT. INDUSTRIAL TRAINING INSTITUTE
UNDER LABOUR, EMPLOYMENT, SKILL DEVELOPMENT & ENTREPRENEURSHIP
DEPARTMENT, GOVERNMENT OF MIZORAM, JANUARY-2024

MECHANICAL ENGINEERING

PAPER-I

Time Allowed : 3 hours FM : 200

SECTION - A ***(Multiple Choice questions) (100 Marks)***

All questions carry equal mark of 2 each. Attempt all questions.

This Section should be answered only on the ***OMR Response Sheet*** *provided.*

1. An isolated system is one in which

(a) both energy and mass cross the boundary of the system

(b) the mass does not cross the boundary, but energy interaction takes place

(c) neither mass nor energy cross the boundary of the system

(d) the mass crosses the boundary but energy does not

2. The perpetual motion machine of the first kind is impossible according to the

(a) zeroth law of thermodynamics (b) first law of thermodynamics

(c) second law of thermodynamic (d) third law of thermodynamics

3. Internal energy of a perfect gas depends on

(a) temperature, specific heat and enthalpy (b) temperature, specific heat and entropy

(c) temperature, specific heat and pressure (d) temperature only

4. During a throttling process

(a) internal energy remains constant (b) enthalpy of fluid remains constant

(c) pressure remains constant (d) temperature remains constant

5. It is impossible to construct an engine which while operating in a cycle, produces no other effect except to extract the heat from a single temperature reservoir and do equivalent amount of work.

(a) It refers to Clasius statement. (b) It refers to Kelvine–Planck's statement.

(c) It refers to Carnot's theorem. (d) It refers to Clasius's theorem

6. Boundary layer thickness is the distance from the boundary to the point where velocity of the fluid is

(a) Equal to 10% of free stream velocity (b) Equal to 50% of free stream velocity

(c) Equal to 90% of free stream velocity (d) Equal to 99% of free stream velocity

7. What is the correct formula for Euler's equation of motion? if, ρ = density of the fluid, p = pressure force g = acceleration due to gravity, v = velocity of the fluid

(a) $(\partial p / \rho) + (\partial g / \rho) + (\partial v / \rho) = 0$ (b) $(\partial p / \rho) + (\partial g / \rho) + (v\, dv) = 0$

(c) $(\partial p / \rho) + (g\, dz) + (v\, dv) = 0$ (d) $(p\, dp) + (g\, dz) + (v\, dv) = 0$

8. When the Mach number is between _____ the flow is called super-sonic flow.
   (a) 1 and 2.5 (b) 2.5 and 4
   (c) 4 and 6 (d) 1 and 6

9. A Carnot cycle operates between temperatures of 727°C and 227°C, the efficiency of the engine is
   (a) 40% (b) 50%
   (c) 60% (d) 45%

10. Which statement is true for Diesel cycle?
   (a) Heat addition at constant volume and heat rejection at constant volume
   (b) Heat addition at constant volume and heat rejection at constant pressure
   (c) Heat addition at constant pressure and heat rejection at constant volume
   (d) Heat addition at constant pressure and heat rejection at constant pressure

11. Heat transfer takes place from a high-temperature body to a low-temperature body according to
   (a) zeroth law of thermodynamics (b) first law of thermodynamics
   (c) second law of thermodynamics (d) third law of thermodynamics

12. A gray body has one of the following properties:
   (a) It reflects all of the energy falling on it. (b) It transmits all of the energy falling on it.
   (c) It has constant emissivity. (d) It absorbs all of the energy falling on it.

13. Which one of the following heat exchanger is most efficient for a given surface area and temperature difference?
   (a) Parallel flow heat exchanger (b) Counter flow heat exchanger
   (c) Cross flow heat exchanger (d) Shell and tube type heat exchanger

14. In air-conditioning of aeroplanes, using air as a refrigerant. the cycle used is
   (a) reversed Carnot cycle (b) reversed -Joule cycle
   (c) reversed Brayton cycle (d) reversed Otto cycle

15. The ideal gas-refrigeration cycle is similar to
   (a) Brayton cycle (b) Reversed Brayton cycle
   (c) Rankine cycle (d) Reversed Rankine cycle

16. The ignition quality of petrol is expressed by
   (a) Cetane number (b) Octane number
   (c) Calorific value (d) All of these

17. The phenomenon occurring in an open channel when a rapidly flowing stream abruptly changes to slowly flowing stream causing a distinct rise of liquid surface, is
   (a) Water hammer (b) Hydraulic jump
   (c) Critical discharge (d) None of the above

18. Stefan-Boltzmann's law is expressed as
   (a) $Q = sAT^4$ (b) $Q = sA^2T^4$
   (c) $Q = sAT^2$ (d) $Q = AT^4$

19. Peclet number is the ratio of _____ number to _____ number.
   (a) Reynolds, Schemdit (b) Prandtl, Weber
   (c) Prandtl, Schemdit (d) Reynolds, Prandtl

20. The difference between dry bulb temperature and wet bulb temperature, is called

(a) dry bulb depression
(b) wet bulb depression
(c) dew point depression
(d) degree of saturation

21. The process generally used in winter air conditioning to warm and humidify the air, is called

(a) humidification
(b) dehumidification
(c) heating and humidification
(d) cooling and dehumidification

22. The Euler's equation of motion is a

(a) statement of energy balance
(b) statement of conservation of momentum for a real fluid
(c) statement of conservation of momentum for an incompressible flow
(d) statement of conservation of momentum for the flow of an inviscid fluid

23. Which one of the following is the dimension of specific weight of a liquid?

(a) $[ML^{-3}T^{-2}]$
(b) $[ML^{3}T^{-2}]$
(c) $[ML^{-2}T^{-2}]$
(d) $[ML^{2}T^{-2}]$

24. The conditions across a normal shock

(a) Lie at the intersection of the Fanno and Rayleigh lines for the flow
(b) Have the same stagnation temperature
(c) Both (a) and (b) are true
(d) Both (a) and (b) are false

25. Pitot-tube is used to measure

(a) discharge
(b) average velocity
(c) velocity at a point
(d) pressure at a point

26. The square root of the ratio of inertia force to force due to compressibility is known as

(a) Reynold number
(b) Froude number
(c) Mach number
(d) Euler number.

27. Consider the following assumptions:

1. Steady flow
2. Inviscid flow
3. Flow along a streamline
4. Conservative force field

For Bernoulli's equation to be valid between any two points in a flow field, besides incompressible flow and irrotational flow, the assumptions required would include

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

28. Rayleigh line flow is a flow in a constant area duct

(a) with friction but without heat transfer
(b) without friction but with heat transfer
(c) with both friction and heat transfer
(d) without either friction or heat transfer

29. The Grashof number in natural convection plays same role as

(a) Prandtl number (Pr) in forced convection
(b) Reynolds number (Re) in forced convection
(c) Nusselt number (Nu) in forced convection
(d) none of the above

30. In a refrigeration system, the expansion device is connected between the

(a) Compressor and Condenser
(b) Condenser and Receiver
(c) Receiver and Evaporator
(d) Evaporator and Compressor

31. The knocking in spark ignition engines can be reduced by

(a) Retarding the spark
(b) Increasing the engine speed
(c) Both (a) and (b)
(d) None of these

32. The air standard Otto cycle comprises

(a) two constant pressure processes and two constant volume processes
(b) two constant pressure and two constant entropy processes
(c) two constant volume processes and two constant entropy processes
(d) none of the above.

33. The value of the compressibility of an ideal fluid is

(a) Zero
(b) Unity
(c) Infinity
(d) More than that of a real fluid

34. When a tank containing liquid moves with an acceleration in the horizontal direction, then the free surface of the liquid

(a) Remains horizontal
(b) Becomes curved
(c) Falls on the front-end
(d) Falls on the back end

35. Which of the following results are more accurate?

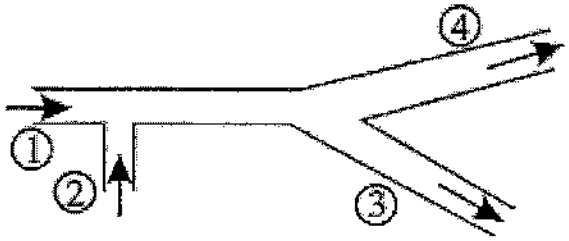
(a) Rectangular notch
(b) Triangular weir
(c) Both are equally accurate
(d) Rectangular weir

36. The phenomenon occurring in an open channel when a rapidly flowing stream abruptly changes to slowly flowing stream causing a distinct rise of liquid surface, is

(a) Water hammer
(b) Hydraulic jump
(c) Critical discharge
(d) None of the above

37. A pipe flow system with flow direction is shown in the Fig. The following table gives the velocities and the corresponding areas:

Pipe No.	Area (cm^2)	Velocity (cm/s)
1	50	10
2	50	V_2
3	80	5
4	70	5



The value of V_2 is

(a) 2.5 cm/s
(b) 5.0 cm/s
(c) 7.5 cm/s
(d) 10.0 cm/s

38. Specific speed of a turbine is defined as the speed of the turbine which

(a) produces unit power at unit head
(b) produces unit horse power at unit discharge
(c) delivers unit discharge at unit head
(d) delivers unit discharge at unit power.

39. A nozzle is designed for

(a) maximum pressure at the outlet
(b) maximum discharge
(c) maximum pressure and maximum discharge
(d) maximum kinetic energy at the outlet

40. A submerged body is said to be in a stable equilibrium, if its centre of gravity_____ the centre of buoyancy.

(a) Coincides with
(b) Lies below
(c) Lies above
(d) None of these

41. Radiation shields are used

(a) To increase radiant heat transfer
(b) To decrease radiant heat transfer
(c) To maintain radiant heat transfer constant
(d) None of the above

42. Heat is mainly transferred by conduction, convection and radiation in

(a) Insulated pipes carrying hot water
(b) Refrigerator freezer coil
(c) Boiler furnaces
(d) Condensation of steam in a condenser

43. Shape factor for sphere is

(a) $4 \pi r_1 r_2$
(b) $4 \pi r_1 r_2/r_2 - r_1$
(c) $4 \pi /r_2 - r_1$
(b) $r_1 r_2/r_2 - r_1$

44. For a prescribed temperature difference, bodies with the same shape factor will allow heat conduction proportional to

(a) k/2
(b) 2k
(c) k
(d) k/4

45. Fourier law of heat conduction is based on the assumption that

(a) Heat flow through a solid is one dimensional
(b) Heat flow is in steady state
(c) Both (a) and (b)
(d) None of the options

46. The draught in a boiler is provided to

(a) force the air on the furnace
(b) force the hot gases on superheater
(c) discharge the flue gases through chimney
(d) all of the above

47. A Cornish boiler is

(a) multi-tubular boiler
(b) a water-tube boiler
(c) a fire tube boiler
(d) flue gas surrounds the tube

48. By first law of thermodynamics,

(a) $Q=\Delta E-W$
(b) $Q=\Delta E+W$
(c) $Q=-\Delta E-W$
(d) $Q=-\Delta E+W$

49. Second law of thermodynamics defines

(a) internal energy
(b) work
(c) enthalpy
(d) entropy

50. The type of rotary compressor used in gas turbine is of .....

(a) Centrifugal type
(b) Axial flow type
(c) Radial flow type
(d) None of this

SECTION - B *(100 Marks)*

*All questions carry equal marks of **10** each.*
*This Section should be answered only on the **Answer Sheet** provided.*

1. Define steady flow process. Write the steady flow energy equation (SFEE) and explain the significance of each term. **(10)**
2. Define the following terms: **(2×5=10)**
   (a) Coefficient of performance (b) tonne of refrigeration
3. Derive an expression for the C.O.P of a Bell- Coleman Cycle refrigeration system. A refrigerator is working between the temperature -30°C and 35°C. What is the maximum possible COP of the refrigerator? If the actual COP is 75% of maximum, determine the refrigeration effect per KW of power input. **(5+5=10)**
4. What do you mean by one dimensional isentropic flow? Enumerate the governing equations related to isentropic flow. **(5+5=10)**
5. Discuss briefly the basic performance parameters in I.C engine. Compare in brief the detonation phenomenon in SI and CI engine. **(5+5=10)**
6. State first law of thermodynamics. Define entropy and show that entropy is a property of a system. **(2+8=10)**
7. State the Bernoulli's equation. List out the assumptions that are used to derive the equation. **(10)**
8. Define the terms: Major energy losses and minor energy losses in pipe. **(10)**
9. What are the types of nozzles? Explain with neat diagrams. **(10)**
10. A centrifugal compressor delivers 50 kg of air per minute at a pressure of 2 bar and 97°C. The intake pressure and temperature of the air is I bar and 15°C. If no heat is lost to the surrounding, find: (i) index of compression and (ii) power required, if the compression is isothermal. Take R = 287 J/kg K. **(10)**

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