MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE (M.E.S.) UNDER PUBLIC HEALTH DEPARTMENT, GOVERNMENT OF MIZORAM, MARCH, 2019.

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. The work done by a closed system in a reversible process is always _____ that done in an irreversible process.
    (a) less than or more than
    (b) equal to
    (c) less than
    (d) more than

2. A piston-cylinder device initially contains air at 150 kPa and 27°C. At this state, the volume is 400 litre. The mass of the piston is such that a 350 kPa pressure is required to move it. The air is now heated until its volume has doubled. Determine the total heat transferred to the air.
    (a) 747 kJ
    (b) 757 kJ
    (c) 767 kJ
    (d) 777 KJ

3. The temperature range for transition boiling is:
    (a) $30°C \le \Delta T_e \le 150°C$
    (b) $5°C \le \Delta T_e \le 30°C$
    (c) $30°C \le \Delta T_e \le 120°C$
    (d) $\Delta T_e \ge 150°C$

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

    (a) $k_1 k_2$
    (b) $\dfrac{(k_1 + k_2)}{k_1 k_2}$
    (c) $\dfrac{2k_1 k_2}{(k_1 + k_2)}$
    (d) $k_1 + k_2$

5. Choose the correct statement among the following:
    (a) Temperature is an extensive property
    (b) Mass remains same in an open system
    (c) The system boundaries are collapsible and expandable
    (d) An isolated system allows exchange of energy in the form of heat only

6. In a four stroke cycle petrol engine, the compression
    (a) Starts at 40° after bottom dead centre and ends at 30° before top dead centre
    (b) Starts at 40° before bottom dead centre and ends at 30° after bottom dead centre
    (c) Starts at bottom dead centre and ends at top dead centre
    (d) May start and end anywhere

7. Cavitation is caused by
   (a) high velocity
   (b) low pressure
   (c) weak material
   (d) high pressure

8. The time required to close a valve gradually is (where L is the length of pipe and C = velocity of pressure wave)
   (a) $\dfrac{2L}{C}$
   (b) $\geq \dfrac{2L}{C}$
   (c) $> \dfrac{2L}{C}$
   (d) $> \dfrac{4L}{C}$

9. The total energy developed by the hydraulic oil in a system is given as
   (a) Total energy = (Potential energy + Pressure energy)
   (b) Total energy = (Potential energy + Kinetic energy)
   (c) Total energy = (Potential energy – Kinetic energy)
   (d) None of these

10. If R_e is the Reynold's number, the coefficient of friction for laminar flow is
   (a) $\dfrac{4}{R_e}$
   (b) $\dfrac{8}{R_e}$
   (c) $\dfrac{12}{R_e}$
   (d) $\dfrac{16}{R_e}$

11. Depending on the radiating properties, a body will be opaque when
   (a) p = 0, x = 0 and a = 1
   (b) p = 1, x = 0 and a = 0
   (c) p = 0, x = 1 and a = 0
   (d) x - 0, a + p = 1
   where a = absorptivity, p = reflectivity, x = transmissivity

12. The fluid forces considered in the Navier Stokes equation are
   (a) gravity, pressure and viscous
   (b) gravity, pressure and turbulent
   (c) viscous, pressure and viscous
   (d) gravity, turbulent and viscous

13. For a hypersonic flow, the mach number is
   (a) unity
   (b) greater than unity
   (c) greater than 2
   (d) greater than 4

14. An object having 10 kg mass weighs 9.81 kg on a spring balance. The value of 'g' at this place is
   (a) 10 m/sec^2
   (b) 9.81 m/sec^2
   (c) 10.2 m/sec^2
   (d) 9 m/sec^2

15. If mercury in a barometer is replaced by water, the height of 3.75 cm of mercury will be following cm of water
   (a) 51 cm
   (b) 50 cm
   (c) 52 cm
   (d) 52.2 cm

16. The ignition of the charge by some hot surface within the engine before the passage of spark is called
   (a) Pre-ignition
   (b) Detonation
   (c) Ignition delay
   (d) Auto-ignition

17. A fluid is said to be ideal, if it is
   (a) incompressible
   (b) inviscous
   (c) inviscous and incompressible
   (d) viscous and compressible

18. Which of the following is the lightest and most volatile liquid fuel?

    (a) Diesel
                (b) Kerosene

    (c) Fuel oil
              (d) Gasoline

19. The air standard efficiency of an I.C. engine is given by (where r = Compression ratio, and g = Ratio of specific heats)

    (a) $1 - r^{g-1}$
             (b) $1 + r^{g-1}$

    (c) $1 - (1/r^{g-1})$
       (d) None of these

20. For the same compression ratio, the efficiency of dual combustion cycle is

    (a) greater than Diesel cycle and less than Otto cycle

    (b) less than Diesel cycle and greater than Otto cycle

    (c) greater than Otto cycle

    (d) less than Diesel cycle

21. Which of the following cycles uses air as the refrigerant

    (a) Ericsson
            (b) Stirling

    (c) Carnot
              (d) Bell-coleman

22. The COP of domestic refrigerator is

    (a) less than 1
          (b) more than 1

    (c) equal to 1
           (d) depends upon the make

23. A counter flow shell and tube heat exchanger is used to heat water with hot exhaust gases. The water (c=4180 J/kgK) flows at the rate of 2 kg/s and the exhaust gases (c=1000 J/kgK) flow at the rate of 5 kg/s. If the heat transfer surface area is 32 m² and the overall heat transfer coefficient is 200 W/m²K. The NTU of the heat exchanger is

    (a) 4.5
            (b) 2.4

    (c) 8.6
            (d) 1.28

24. Property of a fluid by which its own molecules are attracted is called

    (a) adhesion
          (b) cohesion

    (c) viscosity
           (d) surface tension

25. Bernoulli equation deals with the law of conservation of

    (a) mass
            (b) momentum

    (c) energy
            (d) work

26. If jet of water coming out from a nozzle with a velocity 9.81 m/s, the angle of elevation being 30°, the time to reach the highest point is

    (a) 0.25 sec
         (b) 0.50 sec

    (c) 1.0 sec
           (d) 1.5 sec

27. What causes suction of fluid into the gear pump?

    (a) when pressure drops during disengagement of teeth at the suction side

    (b) when pressure increases during disengagement of teeth at the suction side

    (c) when pressure drops during engagement of teeth at the suction side

    (d) when pressure increases during engagement of teeth at the suction side

28. The vapour compression refrigeration employs the following cycle

    (a) Reverse carnot
      (b) Carnot

    (c) Rankine
           (d) Brayton

29. In convection heat transfer from hot flue gases to water tube, even though flow may be turbulent, a laminar flow region (boundary layer of film) exists close to the tube. The heat transfer through this film takes place by

    (a) convection

    (b) radiation

    (c) conduction

    (d) both convection and conduction

30. Which factor is considered while selecting the diameter of piston rod in hydraulic cylinder?

    (a) bore diameter

    (b) length of stroke

    (c) load

    (d) all of these

31. Which of the following relationship is valid only for reversible process undergone by a closed system of simple compressible substance when changes in kinetic and potential energy are neglected?

    (a) $dQ = dU + dW$

    (b) $Tds = dU + pdV$

    (c) $Tds = dU + dW$

    (d) $dQ = dU + pdV$

32. According to kinetic theory of heat

    (a) Temperature should rise during boiling

    (b) Temperature should fall during freezing

    (c) At absolute zero there is absolutely no vibration of molecules

    (d) None of these

33. The pressure exerted by an ideal gas is _____ of the kinetic energy of all the molecules contained in a unit volume of gas.

    (a) One-half

    (b) one-third

    (c) Two-third

    (d) Three-fourth

34. Which of the following statement is incorrect?

    (a) The liquid fuels consist of hydrocarbons.

    (b) The liquid fuels have higher calorific value than solid fuels.

    (c) The solid fuels have higher calorific value than liquid fuels.

    (d) A good fuel should have low ignition point.

35. Continuous flow of fluid is called as

    (a) Continuum

    (b) Invincible flow

    (c) Continuum & Invincible flow

    (d) None of these

36. The volumetric efficiency for reciprocating air compressors is about

    (a) 10 to 40%

    (b) 40 to 60%

    (c) 60 to 70%

    (d) 70 to 90%

37. The stagnation pressure rise in a centrifugal compressor takes place

    (a) In the diffuser only

    (b) In the impeller only

    (c) In the diffuser and impeller

    (d) In the inlet guide vanes only

38. The maximum delivery pressure in a rotary air compressor is

    (a) 10 bar

    (b) 20 bar

    (c) 30 bar

    (d) 50 bar

39. Unit of flow resistance is

    (a) N/m^2

    (b) m^2/N

    (c) kN/kg

    (d) No unit

40. Coefficient of discharge is
   (a) Directly proportional to coefficient of discharge
   (b) Inversely proportional to square of the coefficient of discharge
   (c) Inversely proportional to coefficient of discharge
   (d) Directly proportional to square of coefficient of discharge

41. In velocity compounded turbines flow passage is from
   (a) Moving blades to fixed nozzles
   (b) Fixed nozzles to moving blades
   (c) Fixed blades to moving nozzles
   (d) None of these

42. Reaction turbine is also called as
   (a) Impulse turbine
   (b) Curtis wheel
   (c) Parsons turbine
   (d) None of these

42. Gas turbines operate at pressures _____ than critical pressure ratio.
   (a) Higher
   (b) Lesser
   (c) Does not depend on pressure ratio
   (d) None of these

43. Vapor quality is an
   (a) Extensive property
   (b) Intensive property
   (c) Extensive & Intensive property
   (d) None of these

44. Specific volume of steam is _____ to dryness faction at given temperature.
   (a) Not related
   (b) Indirectly proportional
   (c) Directly proportional
   (d) equal to

45. The rate of energy transferred by convection to that by conduction is called
   (a) Stanton number
   (b) Nusselt number
   (c) Biot number
   (d) Peclet number

46. LMTD in case of counter flow heat exchanger as compared to parallel flow heat exchanger is
   (a) Higher
   (b) Lower
   (c) Same
   (d) Depends on the area of heat exchanger

47. Joule sec is the unit of
   (a) Universal gas constant
   (b) Kinematic viscosity
   (c) Thermal conductivity
   (d) Planck's constant

48. The product of Reynolds number and Prandtl number is known as
   (a) Stanton number
   (b) Biot number
   (c) Peclet number
   (d) Grashoff number

49. An ordinary passenger aircraft requires a cooling system of capacity.
   (a) 2 TR
   (b) 4 TR
   (c) 8 TR
   (d) 10 TR

50. Fourier's law of heat conduction gives the heat flow for
   (a) Irregular surfaces
   (b) Non uniform temperature surfaces
   (c) One dimensional cases only
   (d) Two dimensional cases only

SECTION - B *(Short answer type question)*
(100 Marks)

All questions carry equal marks of 5 each.

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

1. A venturimeter is installed in a horizontal pipe line of 0.3 m diameter. The difference of pressure at entrance and throat read by a mercury manometer is 5 cm, when the water is flowing at the rate of 50 litres per second. Find the diameter of the venturimeter at the throat, if the coefficient of discharge is 0.96.

2. Steam at 350°C flowing in a pipe (k=80W/mK) 5 cm internal diameter is covered with 3 cm thick insulation (k=0.05 W/mK). Heat is loss to the surroundings at 5°C by natural convection and radiation with combined h=20 W/m^2K and h_i=60 W/m^2K. Find (i) the rate of heat loss from the pipe per unit length, (ii) the temperature drops across the pipe and the insulation.

3. Write the different Psychrometric process with detail diagrams.

4. Discuss the principle operation of an Otto cycle with indicator diagram.

5. Write the working principle of a single-acting reciprocating pump with detail schematic diagram.

6. How Cavitation can be eliminated by Pump? Why Centrifugal Pump is not called as a Positive Displacement Type of Pump?

7. Find the mach number when an aeroplane is flying at 900 km/hr through still air having a pressure of $8×10^4$ N/m^2 and temperature -15 °C. Take k =1.4 and R=287 j/kgK. Calculate the pressure, temperature and density of air at the stagnation point on the nose of the plane.

8. Write the characteristics of an ideal working fluid in vapour power cycles.

9. Draw the vapour compression refrigeration cycle with h-s diagram and explain the different components.

10. Derives the temperature distribution for one dimensional steady state heat conduction in a plane wall considering heat generation and show the temperature distribution at the central point.

11. In an automobile washing station, water flows through a long hose of 1.5cm diameter with a speed of 5m/s. If its outlet contains a nozzle of 8mm diameter, what is the velocity and rate of discharge through the nozzle?

12. State Dalton's law of partial pressure and define bypass factor of coil?

13. Carnot engine working between a source temperature of T_2 and sink temperature of T_1 has efficiency of 25%. If the sink temperature is reduced by 20 °C, the efficiency is increased to 30%. Find the source and the sink temperature.

14. Calculate the maximum efficiency of an engine operating between 120 ºC and 35 ºC

15. Explain the Carnot theorem with proof.

16. What is fouling? Explain its effect on the heat exchanger?

17. State Kirchhoff's law of radiation, what is the purpose of radiation shield?

18. What is a boiler mounting? Discuss the different boiler accessories in details.

19. A stream function is given by $w = 3x^2y + (2+t)y^2$. Find the velocity field and determine its value at a point defined by the position vector $r = 1i + 2j - 3k$ when $t = 2$.

20. Discuss the effects of variation of discharge on the efficiency of a pump.

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