MIZORAM PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF M.E.S. UNDER PUBLIC WORKS DEPARTMENT, AUGUST, 2018.

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. Heat transfer takes place as per -

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

(c) second law of the thermodynamics (d) Kirchoff's law

2. The value of Prandtl number for air is about

(a) 0.1 (b) 0.3

(c) 0.7 (d) 1.7

3. 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

4. Depending on the radiating properties, a body will be opaque when

(a) p = 0, x = 0 and a = 1 (b) p=l, 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

5. In counter flow heat exchangers

(a) both the fluids at inlet (of heat exchanger where hot fluid enters) are in their coldest state

(b) both the fluids at inlet are in their hottest state

(c) both the fluids at exit are in their hottest state

(d) one fluid is in hottest state and other in coldest state at inlet

6. A plane wall is 25 cm thick with an area of 1 m^2, and has a thermal conductivity of 0.5 W/mK. If a temperature difference of 60°C is imposed across it, what is the heat flow?

(a) 180 W (b) 140 W

(c) 120 W (d) 160 W

7. Upto the critical radius of insulation

(a) Added insulation will increase heat loss

(b) Added insulation will decrease heat loss

(c) Convective heat loss will be less than conductive heat loss

(d) Heat flux will decrease

8. A wall of thickness 0.6 m has width and has a normal area 1.5 $m^2$and is made up of material of thermal conductivity 0.4 W/mK. The temperatures on the two sides are 800°C. What is the thermal resistance of the wall?

(a) 2 K/W (b) 3.5 K/W

(c) 1 K/W (d) 2.3 K/W

9. The temperature range for transition boiling is:

(a) $30^{\circ}C \le \Delta T_e \le 150^{\circ}C$ (b) $5^{\circ}C \le \Delta T_e \le 30^{\circ}C$

(c) $30 \le \Delta T_e \le 120^{\circ}C$ (d) $\Delta T_e \ge 150^{o}C$

10. Consider the following statements pertaining to heat transfer through fins:

i) Fins are equally effective irrespective of whether they are on the hot side or cold side of the fluid.

ii) the temperature along the fin is variable and hence the rate of heat transfer varies along the fin.

iii) The fins may be made of materials that have a higher thermal conductive than the material of the wall.

iv) Fins must be arranged at right angles to the direction of fluid flow.

Of these statement,

(a) i and ii are correct (b) ii and iv are correct

(c) i and iii are correct (d) ii and iii are correct

11. 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 m^2 and the overall heat transfer coefficient is 200 W/m^2K. The NTU of the heat exchanger is

(a) 4.5 (b) 2.4

(c) 8.6 (d) 1.28

12. Assertion (A) : Surface condensers are designed on the basis that filmwise condensation always exists.

Reasoning (R) : It is not possible to have dropwise condensation on the surface continuously at all times.

Codes:

(a) Both A and R are false (b) Both A and R are true

(c) A is true, R is false (d) A is false, R is true

13. 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) $\frac{(k_1+k_2)}{k_1k_2}$

(c) $\frac{2k_1k_2}{(k_1+k_2)}$ (d) k_1k_2

14. In MLTu system, the dimension of thermal conductivity is

(a) $ML^{-1}T^{-1}\theta^{-1}$ (b) $MLT^{-1}\theta^{-1}$

(c) $MLT^{-3}\theta^{-1}$ (d) $MLT^{-2}\theta^{-1}$

15. For a fully developed laminar flow through a pipe with uniform wall temperature, the heat transfer coefficient is

(a) not directly proportional to the thermal conductivity of fluid film

(b) inversely proportional to the pipe diameter

(c) dependent on fluid velocity

(d) dependent on fluid viscosity

16. Which of the following are intensive properties

i) Kinetic energy ii) Specific enthalpy

iii) Pressure iv) Entropy

Answer:

(a) i and iv (b) ii and iii

(c) i, iii and iv (d) ii and iv

17. Convert the following readings of pressure to kPa, assuming that the barometer reads 760 mm Hg and match the List-i with list-ii:

	List - I		List -II
A.	50 cm Hg vaccum	1.	113 kP
B.	80 cm Hg gauge	2.	34.65 kPa
C.	1.2 m of H_2O gauge	3.	209 kPa

Answer:

	A	**B**	**C**
(a)	1	3	2
(b)	1	2	3
(c)	2	3	1
(d)	3	1	2

18. 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

19. 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

20. The net work output of an ideal regenerative cycle is

(a) more than the net work output of the Rankine cycle

(b) less than the net work output of the Rankine cycle

(c) equal to the net work output of the Rankine cycle

(d) cannot say

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

(a) Ericsson (b) Stirling

(c) Carnot (d) Bell-coleman

22. One ton of refrigeration is equal to the refrigeration effect corresponding to melting of 1000 kg of ice
(a) in 1 hour (b) in 24 minutes
(c) in 24 hours (d) in 12 hours

23. The vapour compression refrigeration employs the following cycle
(a) Reverse carnot (b) Carnot
(c) Rankine (d) Brayton

24. The COP of domestic refrigerator is
(a) less than 1 (b) more than 1
(c) equal to 1 (d) depends upon the make

25. The probability of knocking in diesel engines is increased by
(a) High self ignition temperature (b) Low volatility
(c) Higher viscosity (d) All of these

26. 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

27. The air standard efficiency of an I.C. engine is given by (where r = Compression ratio, and γ = Ratio of specific heats)
(a) $1-r^{\gamma-1}$ (b) $1+r^{\gamma-1}$
(c) $1-(1/r^{\gamma-1})$ (d) None of these

28. 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

29. Which of the following is the lightest and most volatile liquid fuel?
(a) Diesel (b) Kerosene
(c) Fuel oil (d) Gasoline

30. By higher octane number of spark ignition fuel, it is meant that the fuel has
(a) Higher heating value (b) Higher flash point
(c) Lower volatility (d) Longer ignition delay

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

32. Property of a fluid by which its own molecules are attracted is called
(a) adhesion (b) cohesion
(c) viscosity (d) surface tension

33. 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}

34. A balloon lifting in air follows the following principle

(a) Law of gravitation (b) Archimedes Principle

(c) Principle of buoyancy (d) All of these

35. 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

36. Metacentric height is the distance between the metacentre and

(a) water surface (b) center of pressure

(c) center of gravity (d) center of buoyancy

37. For a hypersonic flow, the mach number is

(a) unity (b) greater than unity

(c) greater than 2 (d) greater than 4

38. Cavitation is caused by

(a) high velocity (b) low pressure

(c) weak material (d) high pressure

39. Bernoulli equation deals with the law of conservation of

(a) mass (b) momentum

(c) energy (d) work

40. 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

41. The property of stream function ψ is :

(a) ψ is constant everywhere on any stream line

(b) the flow around any path in the fluid is zero for continuous flow

(c) the velocity vector may be found by differentiating the stream function

(d) all of these

42. The time required to close a valve gradually is (where L is the length of pipe and C = velocity of pressure wave)

(a) $\frac{2L}{C}$ (b) $\geq \frac{2L}{C}$

(c) $> \frac{2L}{C}$ (d) $> \frac{4L}{C}$

43. Low-torque high-speed motors are used in

(a) cranes (b) winches

(c) fans (d) all of these

44. Which of the following statements are true?

i) piston pumps are self priming

ii) piston pumps require high maintenance

iii) piston pumps have low cost of production

iv) piston pumps have low volumetric efficiency

(a) i and ii (b) iii and iv

(c) i and iii (d) all of these

45. 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

46. 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

47. When is a pressure reducing valve used?

(a) it is used when higher pressure than system pressure is required

(b) it is used when lower pressure than system pressure is required

(c) when absolute zero pressure is required

(d) all of these

48. 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

49. If jet of water coming out from a nozzle with a velocity of 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

50. If R_e is the Renold's number, the coefficient of friction for laminar flow is

(a) $\frac{4}{R_e}$ (b) $\frac{8}{R_e}$

(c) $\frac{12}{R_e}$ (d) $\frac{16}{R_e}$

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. Velocity distribution in a pipe is given by $\frac{U}{U_{\max}} = 1 - \left(\frac{r}{R}\right)^n$. Where, U_{max} = Maximum velocity at the centre of pipe. U = Velocity at a distance r. R = radius of the pipe. Obtain an expression for mean velocity in terms of U_{max} and n.

2. For air flow over a flat plate, velocity *(U)* and boundary layer thickness *(δ)* can be expressed respectively, as

$$\frac{U}{U_x} = \frac{3y}{2\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3; \qquad \delta = \frac{4.46x}{\sqrt{\mathrm{Re}_x}}$$

If the free stream velocity is 2 m/s, and air has kinematic viscosity of 1.5×10^{-5} m^2/s and density of 1.23 kg/m^3. Find the wall shear stress at x = 1 m.

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

4. 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.

5. Find the match 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.

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

7. 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^{2}K and h_i=60 W/m^{2}K. Find (i) the rate of heat loss from the pipe per unit length, (ii) the temperature drops across the pipe and the insulation.

8. 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.

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

10. Write the different Psychrometric process with detail diagrams.

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

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

13. Define Energy thickness in a boundary layer and derive the equation of Energy thickness for a boundary layer.

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

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

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

17. What is human Comfort according to ASHRAE? Explain what are the factors affecting human comfort.

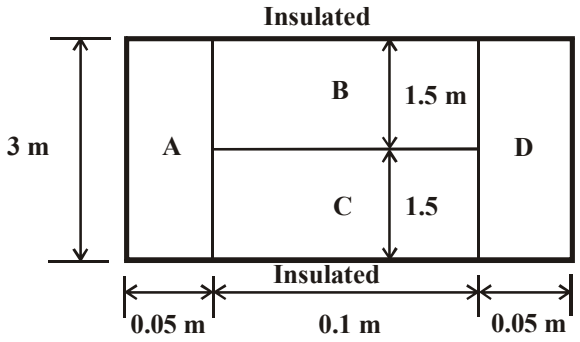
18. Explain the concept of convection boundary layers through velocity, thermal and concentration boundary layer.

19. Liquid mercury flows at a rate of 1.6 kg/s through a copper tube of 20 mm diameter. The mercury enters the tube at 15°C and leaves at 35°C. Calculate the tube length for constant heat flux at the wall which is maintained at an average temperature of 50°C. For Liquid metal flowing through a tube, the following correlation may be used;

$$Nu_d = 7 + 0.025(Pe)^{0.8}$$

Properties of mercury at 25°C are: ρ = 13582 kg/ m^3, c_p =140 J/kg K, ν =1.5 ×10^{-6} m^2/s, k=8.69 W/mK and Pr=0.0248.

20. Find the rate of heat transfer through the composite wall having unit length normal to the plane of paper having thermal conductivity of $K_A = K_D = 50$ W/mK, $K_B = 10$ W/mK, $K_C = 1$ W/mK as shown in the figure below. The inlet temperature is 200°C with heat transfer coefficient of 50 W/m^{2}K and outlet temperature is 25°C with heat transfer coefficient of 10 W/m^{2}K.



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