MIZORAM PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF M.E.S.
UNDER POWER & ELECTRICITY 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. A closed system is a
   - (a) Variable mass and variable energy system
   - (b) Fixed mass and variable energy system
   - (c) Fixed mass and fixed energy system
   - (d) Constant entropy system

2. Thermocouple is based on
   - (a) Joule's effect
   - (b) Peltier effect
   - (c) Seebeck effect
   - (d) Boyle's law

3. Diathermic wall means
   - (a) It would not allow flow of heat
   - (b) It would allow flow of heat
   - (c) There is no such things as diathermic wall
   - (d) It only allows flow of mass

4. Consider the give expression [Tds = dH – Vdp]. The relation is applicable for
   - (a) Reversible process
   - (b) Constant pressure process
   - (c) Constant volume process
   - (d) Any process including irreversible process

5. Heat transfer takes place according to
   - (a) Zeroth law of thermodynamics
   - (b) First law of thermodynamics
   - (c) Second law of thermodynamics
   - (d) Third law of thermodynamics

6. Gibb's free energy 'G' is defined as
   - (a) $G = H-TS$
   - (b) $G = U-TS$
   - (c) $G = U+pV$
   - (d) $G = H+TS$

7. Arrangement for following substances in decreasing order of triple point temperature, is correct
   - (a) $C_2H_2>C_2H_6>CH_4>C_2H_4$
   - (b) $C_2H_2>C_2H_4>CH_4>C_2H_6$
   - (c) $C_2H_6>C_2H_4>CH_4>C_2H_2$
   - (d) $C_2H_4>C_2H_6>C_2H_2>CH_4$

8. Three engine A, B & C operating on Carnot cycle respectively uses air, steam and helium as the working fluid. If all the engines operate within the same high and low temperature limits, then engine will have the highest efficiency.
   - (a) Engine A
   - (b) Engine B
   - (c) Engine C
   - (d) All engines will have the same efficiency

9. Match List-I (process) with List-II (index in pV^n=constant) and select the correct answer using the codes given below the lists

List-I		List-II
a. Adiabatic	1.	$n = $ infinity
b. Isothernmal	2.	$n = \dfrac{C_p}{C_v}$
c. constant pressure	3.	$n = 1$
d. constant volume	4.	$n = \dfrac{C_p}{C_v} - 1$
	5.	$n = $ zero

Codes:	A	B	C	D
(a)	2	3	5	4
(b)	2	3	5	1
(c)	3	2	1	5
(d)	2	5	3	1

10. A heat engine operates between two reservoirs at temperature 800K and 400K. if is possible to change the temperature of either reservoir by 50K. the maximum increase in efficiency is

(a) 0.0625

(b) 0.03

(c) 0.725

(d) 0.045

11. A refrigerating machine working on a reversed Carnot cycle takes out 2kW per minute of heat from the system while between temperature limits 300 K and 200 K. COP and power consumed by the cycle will be respectively

(a) 1 and 1 kW

(b) 1 and 2 kW

(c) 2 and 1 kW

(d) 2 and 2 kW

12. Match List-I (cycle operating between fixed temperature limits) with List-II (characteristics) and select the correct answer using the codes given below the lists

List-I		List-II
a. Carnot cycle	1.	η depends upon cut-off ratio & compression ratio
b. Brayton cycle	2.	η depends upon the volume compression ratio
c. Otto cycle	3.	η depends only upon pressure ratio
d. Diesel cycle	4.	η depends only upon temperature limits

Codes:	A	B	C	D
(a)	3	4	2	1
(b)	4	2	1	3
(c)	4	3	2	1
(d)	3	4	1	2

13. Given below are Maxwell's relations which of the following is correct

(a) $\left(\dfrac{\partial T}{\partial V}\right)_s = \left(\dfrac{\partial p}{\partial S}\right)_v$

(b) $\left(\dfrac{\partial T}{\partial P}\right)_s = -\left(\dfrac{\partial V}{\partial S}\right)_p$

(c) $\left(\dfrac{\partial P}{\partial T}\right)_v = -\left(\dfrac{\partial S}{\partial V}\right)_T$

(d) $\left(\dfrac{\partial V}{\partial T}\right)_p = -\left(\dfrac{\partial S}{\partial p}\right)_T$

14. The slope of an Isotherm on a Mollier diagram is equal to
    (a) Absolute saturation temperature at that pressure
    (b) Saturation temperature at that pressure
    (c) Absolute triple point at that pressure
    (d) Triple point at that pressure

15. Zeroth law of thermodynamics state that
    (a) Two thermodynamic system are always in thermal equilibrium with each other
    (b) If two systems are in thermal equilibrium then the third state will also be in thermal equilibrium
    (c) Two systems not in thermal equilibrium with a third system will also not in thermal equilibrium with each other
    (d) When two systems are in thermal equilibrium with a third system, they are in thermal equilibrium

16. Steady state heat flow implies
    (a) Negligible flow of heat
    (b) No difference of temperature between the bodies
    (c) Constant heat flow rate i.e heat flow rate independent of time
    (d) Uniform rate in temperature rise of a body

17. The rate of heat transfer per unit area per unit thickness of wall when a unit temperature difference is maintained across the opposite faces of the wall is called
    (a) Thermal loading   (b) Thermal conductivity
    (c) Thermal resistance   (d) Heat flux

18. In case of one-dimensional heat conduction in medium with constant properties, T is the temperature at position x at time t. Then $\partial T/\partial t$ is proportional to
    (a) T/x (b) $\partial T/\partial x$
    (c) $\partial^2 T/\partial x \partial t$ (d) $\partial^2 T/\partial x^2$

19. Up to the critical radius of insulation
    (a) Added insulation increases heat loss
    (b) Added insulation decreases heat loss
    (c) Convection heat loss is less than conduction heat loss
    (d) Heat flux decreases

20. Transient conduction means
    (a) Very little heat transfer
    (b) Heat transfer for a short time
    (c) Heat transfer with a very small temperature difference
    (d) Conduction when the temperature at a point varies with time

21. A heat pump working on a reversed Carnot cycle has a COP of 5. If it is made to work as a refrigerator taking 1 kW of work input, the refrigerating effect in kW will be
    (a) 1   (b) 2
    (c) 3   (d) 4

22. The refrigerating system of passenger aircraft works on reversed
    (a) Brayton cycle   (b) Atkinson cycle
    (c) Ericsson cycle   (d) Carnot cycle

23. Lithium bromide is used as absorbent in
    (a) Electrolux refrigerator
    (b) Vapour absorption refrigeration
    (c) Vapour compression refrigeration
    (d) Steam jet refrigeration

24. The refrigerant Freon-12 belongs to the family of
    (a) Methanes
    (b) Ethanes
    (c) Ketones
    (d) Aldehydes

25. In a psychrometric chart, the vertical lines parallel to the ordinate indicate
    (a) Dry bulb temperature
    (b) Wet bulb temperature
    (c) Specific humidity
    (d) Enthalpy of saturation

26. If a Mohr circle is drawn for a fluid element inside a fluid body at rest, it would be
    (a) A circle touching the origin
    (b) A circle not touching the origin
    (c) A point on the shear stress axis
    (d) A point on the normal stress axis

27. Euler's equation of motion
    (a) Is applicable to any fluid
    (b) Considers only gravity and pressure forces acting on an inviscid fluid
    (c) Considers gravity and viscous forces acting on a real fluid
    (d) Considers only the pressure forces acting on a real fluid

28. In a real fluid flow system, the total energy line
    (a) Always slopes in the direction of flow
    (b) Always slopes in the direction of flow except at a pump
    (c) Always decreases in the direction of flow except at a turbine
    (d) Is always at a constant elevation

29. The viscosity of a gas
    (a) Decreases with the increase in temperature
    (b) Increases with the increase in temperature
    (c) Is independent of temperature
    (d) Is independent of pressure for very high pressure intensities

30. Centre of buoyancy always
    (a) Coincides with the centre of gravity
    (b) Coincides with the centroid of the volume of fluid displaced
    (c) Remains above the centre of gravity
    (d) Remains below the centre of gravity

31. If x is the distance from leading edge, then the boundary layer thickness in laminar varies as
    (a) $x^{1/2}$
    (b) $x^{4/5}$
    (c) $x^{3/6}$
    (d) $x^{1/7}$

32. A measure of the effect of compressibility in fluid flow is the magnitude of a dimensionless number known as
    (a) Mach number
    (b) Reynolds number
    (c) Weber number
    (d) Froude number

33. For a fully developed flow through a pipe
    (a) The pressure must drop linearly along the flow
    (b) The head loss increases linearly with the Reynolds number
    (c) The friction factor decreases linearly with the Reynolds number
    (d) The flow must be laminar

34. A cylindrical container contains liquid partially. The cylinder is rotated with a uniform angular velocity of w rad/s. The free surfaces of the liquid during rotation assumes a shape that can be represented by

   (a) $Z = \dfrac{r^2\omega}{2g} + h_o$ (b) $Z = \dfrac{r\omega^2}{2g} + h_o$

   (c) $Z = \dfrac{\omega^2 r^2}{2g} + h_o$ (d) $Z = \dfrac{r^2\omega^2}{2g} + h_o$

35. Match List-I with List-II and select the correct answer using the codes given below the lists

	List-I		List-II
a.	Surface Tension, s	1.	L^2T^{-1}
b.	Volume modulus of elasticity, E	2.	MT^{-2}
c.	Manning's coefficient, n	3.	$ML^{-1}T^{-2}$
d.	Kinematic viscosity, v	4.	$L^{-1/3}T$

Codes:	A	B	C	D
(a)	3	2	4	1
(b)	2	3	1	4
(c)	2	3	4	1
(d)	4	1	2	3

36. Match List-I with List-II and select the correct answer using the codes given below the lists

	List-I		List-II
a.	Continuity equation	1.	Law of conservation of energy
b.	Momentum equation	2.	Concentric circle streamlines
c.	Energy equation	3.	Newton's second law of motion
d.	Free vortex	4.	Law of conservation of mass

Codes:	A	B	C	D
(a)	1	2	3	4
(b)	4	3	1	2
(c)	1	3	4	2
(d)	2	3	4	1

37. Consider the following statements with reference to continuum hypothesis:
   1. It does not ignore the interaction between individual molecules
   2. It considers that molecules are very closely packed
   3. It considers statistical average effect on certain gross macroscopic properties of the material
   4. It fails when the average distance between molecules approaches the characteristics dimensions of flow.

 Which of the statements are correct?
    (a) Both 1 and 2   (b) Both 2 and 3
    (c) Both 3 and 4   (d) Both 1 and 4

38. Match List-I (Fluid property) with List-II (Physical phenomenon in which the property is dominant) and select the correct answer using the codes given below the lists

List-I	List-II
a. Surface tension	1. Echo depth recorder
b. Compressibility	2. Cavitation
c. Vapour pressure	3. Formation of droplets
d. Viscosity	4. Friction in pipes

Codes:	A	B	C	D
(a)	1	3	2	4
(b)	3	1	2	4
(c)	3	1	4	2
(d)	3	4	2	1

39. A Newtonian fluid fills the clearance between a shaft and a sleeve, when a force of 0.8 kN is applied to the shaft, parallel to the sleeve, the shaft attains a speed of 1.5 cm/s. if a force of 2.4 kN is applied instead the shaft would move with a speed of

(a) 0.5 cm/s   (b) 13.5 cm.s

(c) 1.5 cm/s   (d) 4.5 cm/s

40. A thin smooth plate 1m wide and 2m long is towed through water at a velocity of 2m/s. Assuming that boundary remains laminar (kinematic viscosity $= 10^{-6}$ m²/s)

(a) 5.3 N   (b) 26.6 N

(c) 53 N   (d) 72.5 N

41. An Impulse Turbine
(a) Is most suited for low head installation
(b) Always operates submerged
(c) Makes use of draft tube
(d) Operates with initial complete conversion of pressure head to velocity head

42. Efficiency of Pelton wheel shall be maximum if the ratio of jet velocity to tangential velocity of the wheel is

(a) 1/2   (b) 1

(c) 2   (d) 4

43. Which of the following water turbine does not require a draft tube

(a) Propeller turbine   (b) Pelton turbine

(c) Kaplan turbine   (d) Francis turbine

44. Match List-I with List-II and select the correct answer using the codes given below the lists

List-I (Type of turbine)	List-II (Type of features)
a. Propeller	1. Inward flow reaction
b. Francis	2. Tangential flow impulse
c. Kaplan	3. Axial flow reaction with fixed vanes
d. Pelton	4. Axial flow reaction with adjustable vanes

Codes:	A	B	C	D
(a)	2	4	1	3
(b)	3	4	1	2
(c)	2	1	4	3
(d)	3	1	4	2

45. Match List-I (Type of pump) with List-II (Liquid handled) and select the correct answer using the codes given below the lists

List-I	**List-II**
a. Closed impeller pump	1. Sandy water
b. Semi-open impeller pump	2. Acids
c. Open-impeller pump	3. Sewage water

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

46. The heat absorbed by water at its saturation temperature to get converted into dry steam at the same temperature is called

(a) sensible heat   (b) specific heat

(c) latent heat   (d) total heat

47. Clausius-Clapeyron equation gives the slope of the curve in

(a) p-v diagram   (b) p-h diagram

(c) p-t diagram   (d) t-s diagram

48. Constant pressure lines in superheated region of the Mollier diagram will have

(a) a positive slope   (b) a negative slope

(c) zero slope   (d) both positive and negative slope

49. The function of precipitator in a boiler is to

(a) control the water particles going along with steam

(b) minimize the ash particles in flue gases escaping through chimney

(c) control the rate of combustion of fuel

(d) check the chemical impurities in feed water

50. The reheat cycle of power plant is mainly adopted to

(a) improve thermal efficiency

(b) decrease the moisture content in low pressure stages to safe value

(c) decrease the capacity of condenser

(d) recover the waste heat of boiler

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. Define thermodynamic property, state, path, process and cycle.

2. Define Zeroth law of thermodynamics. Write its importance in thermodynamics.

3. Define 'internal energy' and prove that it is a property of a system.

4. State the First Law of Thermodynamics and prove that for a non-flow process, it leads to the energy equation $Q = \Delta U + W$.

5. Define heat engine, refrigerator and heat pump.

6. Explain the mechanisms of heat conduction in gases, liquids and solids.

7. What is a black body? Define emissivity and a gray body.

8. Why is there a negative sign in the Fourier's law of heat conduction?

9. What do you understand by mixed flow and unmixed flow?

10. Define refrigerating effect. What is one tonne of refrigeration? What is the basic formula for calculating the tonnage of refrigeration?

11. Define "Compressibility" and "Bulk Modulus".

12. Distinguish between Newtonian and Non-Newtonian Fluids.

13. Distinguish between gauge pressure, absolute pressure and vacuum pressure.

14. State the conditions for the stability of floating bodies.

15. Define continuity equation and Bernoulli's equation.

16. Explain how hydraulic turbines are classified.

17. What is cavitation? How does it affect the performance of hydraulic machines?

18. Classify the steam turbines and differentiate between steam turbine and steam engines.

19. What do you understand by nozzle? Discuss different types of nozzles.

20. Differentiate between fire tube and water tube boilers.

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