IES-2011 UPSC (ESE)
MECHANICAL ENGINEERING
Paper I

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.

2. ENCODE CLEARLY THE TEST BOOKLET SERIES A, B, C OR D AS THE CASE MAY BE IN THE APPROPRIATE PLACE IN THE ANSWER SHEET.

3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. **DO NOT** write **anything else** on the Test Booklet.

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 all your response **ONLY** on the separate Answer Sheet provided. See direction 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 rake 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 IN THE OBJECTIVE TYPE QUESTION PAPERS.
    (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 a 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.

01. Which one of the following represents open thermodynamic system?
    (A) Manual ice cream freezer   (B) Centrifugal pump
    (C) Pressure cooker   (D) Bomb calorimeter

Ans: (b)

02. A thermodynamic system is considered to be an isolated one if
    (A) Mains transfer and entropy change are zero
    (B) Entropy change and energy transfer are zero
    (C) Energy transfer and mass transfer are zero
    (D) Mass transfer and volume change are zero

Ans: (c)

03. Reduced pressure is
    (A) Always less than atmospheric pressure   (B) Always unity
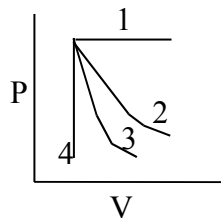   (C) An index of molecular position of a gas   (D) Dimensionless

Ans: (d)

04. Match List I with List II and select the correct answer using the code given below the lists:

List I	List II
A. $n = \infty$	
B. $n = 1.4$	
C. $n = 1.0$	
D. $n = 0$	

Code :

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

Ans: (a)

05. Match List I with List II and select the correct answer using the code given below the lists:

List I	List II
A. Interchange of matter is not possible in a	1. Open system
B. Any processes in which the system returns to its original condition or state is called	2. System
C. Interchange of matter is possible in a	3. Closed system

D. The quantity of matter under   4. Cycle
     consideration in thermodynamics
     is called

Code :

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

Ans: (d)

06. A closed system is one in which
   (A) Mass does not cross boundaries of the system, though energy may do so
   (B) Mass crosses the boundary but not the energy
   (C) Neither mass nor energy cross the boundary of the system
   (D) Both energy and mass cross the boundaries of the system
Ans: (a)

07. Work transfer between the system and the surroundings
   (A) Is a point function   (B) Is always given by $\int$ P dv
   (C) Is a function of pressure only (D) Depends on the path followed by the system
Ans: (d)

08. Air is being forced by the bicycle pump into a tyre against a pressure of 4-5 bars. A slow
    downward movement of the piston can be approximated as
   (A) Isobaric process
   (B) Adiabatic process
   (C) Throttling process
   (D) Isothermal process
Ans: (d)

09. Isentropic flow is
   (A) Irreversible adiabatic flow   (B) Reversible adiabatic flow
   (C) Ideal fluid flow   (D) Frictionless reversible flow
Ans: (b)

10. Increase in entropy of a system represents
   (A) Increase in availability of energy   (B) Increase in temperature
   (C) Decrease in pressure   (D) Degradation of energy
Ans: (d)

11. The value of $\oint \dfrac{dQ}{T}$ for an irreversible cycle is

   (A) Equal to zero   (B) Greater than zero   (C) Less than zero   (D) Unity
Ans: (c)

12. Lowest COP is of vapour
   (A) Compression cycle with superheated vapour
   (B) Compression cycle with dry compression
   (C) Compression cycle with wet compression
   (D) Absorption cycle

13. The cycle in which heat is supplied at constant volume and rejected at constant pressure is known as
    (A) Dual combustion cycle   (B) Diesel cycle
    (C) Atkinson cycle   (D) Rankine cycle
Ans: (c)

14. The boundary layer separation occurs when
    (A) Pressure gradient is positive   (B) Pressure gradient is zero
    (C) Pressure gradient is negative   (D) none of the above
Ans: (a)

15. For minimum work input in a two-stage compression process the intermediate pressure is the
    (A) Arithmetic mean of suction and discharge pressures
    (B) Logarithmic means of suction and discharge pressures
    (C) Geometric mean of suction and discharge pressures
    (D) Hyperbolic mean of suction and discharge pressures
Ans: (c)

16. Air injection is IC engine refers to injection of
    (A) Air only   (B) Liquid fuel only   (C) liquid fuel and air   (D) Supercharging air
Ans: (b)

17. Supercharging is the process of
    (A) Supplying the intake of an engine with air at a density greater than the density of the surrounding atmosphere
    (B) Providing forced cooling air
    (C) Injection of compressed air to remove combustion products fully
    (D) Raising exhaust pressure
Ans: (a)

18. Turbo prop-engine has the following additional feature over the turbojet :
    (A) Propeller   (B) Diffuser
    (C) Starting engine   (D) Turbine and combustion chamber
Ans: (a)

19. In the SI engine, highest UBHC concentration is observed during
    (A) Maximum load   (B) Acceleration   (C) Deceleration   (D) Idling
Ans: (d)

20. Match List I with List II and select the correct answer using the code given below the lists :

List I	List II
A. The rich mixture which provides maximum power gives large amounts of	1. Hydrocarbon emission
B. The condition like wall quenching	2. NO$_X$ in exhaust gases

4

and wall deposits results in

C. Addition of tetraethyl lead is being eliminated because of	3. CO and hydrocarbons in exhaust gases
D. The normal compression ratio is dropped from 10.5 : 1 to 8 : 1 to reduce	4. Adverse effects on exhaust emission

Code :

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

Ans: (d)

21. Pistons of Diesel engines are usually cooled by
    (A) Air   (B) Water   (C) Lubricating all   (D) Fuel oil
Ans: (a)

22. When a hydrocarbon fuel burns in excess air Orsat analysis of products of combustion will show
    (A) CO, CO_2 and N_2 (B) CO_2, CO, N_2 and H_2O
    (C) CO_2, N_2, O_2 and H_2O (D) CO_2, N_2 and O_2
Ans: (d)

23. What will be the products of combustion shown by an Orsat analyzer when natural gas burns in deficit air ?
    (A) CO_2, O_2 and N_2 (B) CO_2, CO, and N_2
    (C) CO_2, CO, N_2 and H_2O (D) CO_2, CO, N_2 and O_2
Ans: (b)

24. The energy produced by 4-5 tons of high grade coal is equivalent to the energy produced by
    (A) 1 kg of Uranium   (B) 1 gram of Uranium
    (C) 100 grams of Uranium   (D) 10 grams of Uranium
Ans: (b)

25. Enriched Uranium is one in which
    (A) Percentage of U^{235} has been artificially increased
    (B) Percentage of U^{238} has been artificially increased
    (C) Percentage of U^{234} has been artificially increased
    (D) Extra energy is pumped from outside
Ans: (a)

26. Which one of the following statements is not correct ?
    (A) Fusion is the combination of heavy nuclei of elements resulting in the release of heat energy

(B) Neutron bombardment is the most common and practiced method of initiation of reaction in fission materials

(C) When the multiplication factor is greater than 1, the chain reaction is uncontrollable

(D) The reactor produces α, β, γ and neutron radiations. Of all these γ radiation is the most dangerous

Ans: (a)

27. The reflectivity in a reactor depends upon
    (A) Geometry of the reflector   (B) Energy of neutrons
    (C) Properties of reflector   (D) All of these

Ans: (d)

28. Shielding in a nuclear power plant is done
    (A) To protect against neutron and gamma rays
    (B) To absorb excess neutrons
    (C) To slow down the speed of fast moving neutrons
    (D) To return the neutrons back into the core of the reactor

Ans: (a)

29. This substance has the minimum value of thermal conductivity :
    (A) Air   (B) Water   (C) Plastic   (D) Rubber

Ans: (a)

30. Dimensionless time is represented by
    (A) Biot number   (B) Fourier number
    (C) Euler number   (D) Graetz number

Ans: (b)

31. If the radius of any current carrying conductor is less than the critical radius, then the addition of electrical insulation will enable the wire to carry a higher current because
    (A) The heat loss from the wire would decrease
    (B) The heat loss from the wire would increase
    (C) The thermal resistance of the insulation is reduced
    (D) The thermal resistance of the conductor is increased

Ans: (b)

32. Match List I with List II and select the correct answer using the code given below the lists:

List I	List II
A. Number of transfer units	1. Regenerators
B. Periodic flow heat exchangers	2. Fouling factor
C. Phase change	3. A measure of heat exchanger size
D. Deposition on heat exchanger surface	4. Condensers

Code:

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

Ans: (c)

33. Floating heads are provided in heat exchangers to

(A) Accommodate vapours released
(B) Decrease pressure drop
(C) Regulate the flow
(D) Avoid deformation of tubes due to thermal expansion

Ans: (c)

34. If the thermal conductivity of a material of wall varies as $K_o(1 + at)$ then the temperature at the centre of the wall as compared to that in case of constant thermal conductivity will be

(A) More   (B) Less   (C) Same   (D) Possible in all as above

Ans: (a)

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

List I	List II
A. Stanton number	1. Natural convection
B. Grashof number	2. Mass transfer
C. Peclet number	3. Forced convection
D. Schmidt number	4. Forced convection for small Pr, Number

Code :

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

Ans: (b)

36. In the film established along a vertical plate during condensation of any vapour over the plates, the temperature distribution curve is

(A) Concave upwards   (B) Concave downwards
(C) Parabolic   (D) Straight line

Ans: (d)

37. In spite of large heat transfer coefficients in boiling liquids, cavities are used advantageously when entire surface is exposed to

(A) Nucleate boiling   (B) Film boiling
(C) Transition boiling   (D) Pool boiling

Ans: (c)

38. For a fluid flowing over a flat plate, the Nusselt number at a point 0.5 m from the leading edge is 100. If the thermal conductivity of the fluid is 0.025 W/mK, the coefficient of convective heat transfer is

(A) 2000 W/m^{2}K   (B) 5 W/m^{2}K
(C) 5×10^{-4} W/m^{2}K   (D) 1.25×10^{-4} W/m^{2}K

Ans: (b)

39. The unit of the following parameter is not m^2/s :

(A) Thermal diffusivity   (B) Kinematic viscosity
(C) Mass diffusivity   (D) Dynamic viscosity

Ans: (d)

40. Ice is very close to a
    (A) Gray body   (B) Black body   (C) White body   (D) Specular body
Ans: (b)

41. In a refrigeration plant, if the condenser temperature increases, the power input to the compressor will
    (A) Increase   (B) Decrease   (C) Remain the same   (D) Be unpredictable
Ans: (a)

42. In gas cycle refrigeration system, an expander replaces the throttle value of a vapour compression system, because
    (A) The pressure drop obtained is not adequate
    (B) The drop in temperature by throttling the gas is very small
    (C) It reduces the irreversibility in the system
    (D) Heat loss is significantly decreased with the expander
Ans: (c)

43. In an aircraft refrigeration system, the pressure at the cooling turbine outlet is equal to
    (A) Ambient pressure   (B) Cabin pressure
    (C) Compressor inlet pressure   (D) Evaporator pressure
Ans: (d)

44. A condenser of a refrigeration system rejects heat at a rate of 120 kW, while the compressor of the system consumes a power of 30 kW. The COP of the system will be
    (A) 1/4   (B) 1/3   (C) 3   (D) 4
Ans: (c)

45. Which of the following is not an essential component of any refrigeration system, where refrigeration effect is produced by vaporization of refrigerant ?
    (A) Compressor   (B) condenser   (C) Evaporator   (D) Expansion device
Ans: (a)

46. If the specific humidity of moist air remains the same but its dry bulb temperature increases, its dew point temperature
    (A) Remains the same   (B) Increases   (C) Decreases
    (D) May increase or decrease depending on its relative humidity
Ans: (a)

47. In a adiabatic saturation process of air
    (A) The enthalpy remains constant   (B) The temperature remains constant
    (C) The absolute humidity remains constant (D) The relative humidity remains constant
Ans: (a)

48. If air flows over a cooling coil, dehumidification of air will take place if the coil surface temperature is below the following of the entering air :
    (A) Wet bulb temperature   (B) Dry bulb temperature
    (C) Dew point temperature   (D) Adiabatic saturation temperature
Ans: (c)

49. In winter air-conditioning, the process is
    (A) Heating, humidification and cooling   (B) Heating, humidification and heating
    (C) Heating, dehumidification and heating   (D) Cooling, dehumidification and heating
Ans: (b)

50. For a given by bulb temperature, as the relative humidity decreases, the wet bulb
    temperature will
    (A) Increase   (B) Decrease   (C) Be the same   (D) Depend on other factors
Ans: (b)

51. In summer, air may be cooled and dehumidified by spraying chilled water to air in the
    form of mist. The minimum temperature to which air may be cooled is the
    (A) Wet bulb temperature   (B) Adiabatic saturation temperature
    (C) Apparatus dew point   (D) Dry bulb temperature
Ans: (a)

52. The centre of pressure for an inclined surface area
    (A) Lies below the centroid of the surface strain
    (B) Coincides with the centroid
    (C) Lies above the centroid of the surface
    (D) None of the above
Ans: (a)

53. Newton's law of viscosity relates
    (A) Velocity gradient and rate of shear strain
    (B) Rate of shear deformation and shear stress
    (C) Shear deformation and shear stress
    (D) Pressure and volumetric strain
Ans: (b)

54. Match List I with List II and select the correct answer using the code given below the
    lists:

List I	List II
A. Capillarity	1. Cavitation
B. Vapour Pressure	2. Density of water
C. Viscosity	3. Shear forces
D. Specific gravity	4. Surface tension

Code:

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

Ans: (d)

55. By supercharging the diesel engine, the possibility of knocking
    (A) Decreases   (B) Increases   (C) Remains constant
    (D) None of the above
Ans: (a)

56. With increase in pressure the bulk modulus of elasticity
   (A) Increases   (B) Decreases   (C) Remains constant
   (D) Increases and then decreases
Ans: (a)

57. Calculation of meta-centric height of a floating body involves second moment of area.
   The axis about which this moment is to be calculated passes through the
   (A) Top horizontal surface of the body   (B) Bottom horizontal surface of the body
   (C) Centre of gravity of the body   (D) Centre of buoyancy
Ans: (b)

58. The pressure in Pascal corresponding to 3 cm column of Mercury is
   (A) 7988.6   (B) 3994.3   (C) 2662.8   (D) 1331.4
Ans: (b)

59. Pascal's law states that pressure at a point is equal in all directions in a
   (A) Liquid at rest   (B) Fluid at rest   (C) Laminar flow   (D) Turbulent flow
Ans: (b)

60. As a ship enters into a river from sea, one can expect that
   (A) It rises a little
   (B) It sinks a little
   (C) It remains at the same level
   (D) Its level depends on the material used for construction
Ans: (b)

61. The buoyancy force is
   (A) Equal to volume of liquid displaced
   (B) Force necessary to maintain equilibrium of a submerged body
   (C) The resultant force acting on a floating body
   (D) The resultant force on a body due to the fluid surrounding it
Ans: (d)

62. The submerged body will be in stable equilibrium if the centre of buoyancy B
   (A) Is below the centre of gravity G   (B) Coincides with G
   (C) Is above the meta-centre M   (D) Is above G
Ans: (d)

63. The stability of a floating body is obtained when its
   (A) Centre of gravity is below the of buoyancy
   (B) Meta-centric height is negative
   (C) Meta-centric height is positive
   (D) Meta-centric height is zero
Ans: (c)

64. If flow conditions satisfy 'Laplace equation' then
   (A) Flow is rotational
   (B) Flow does not satisfy continuity equation

(C) Flow is irrotational but does not satisfy continuity equation

(D) Flow is irrtational and safisfies continuity equation

Ans: (d)

65. The stream function of a two-dimensional flow is $\psi = 2xy$. The flow is

   (A) Rotational   (B) Irrotational

   (C) Vortex flow   (D) Unsteady pulsating flow

Ans: (b)

66. Consider the following statements pertaining to kinematics and dynamics of fluid flow :

   1. For $\psi = x^2 – x^2$, velocity at $(1, 1)$ is $2\sqrt{2}$

   2. For all of flow, stream and potential functions exist

   3. Bernoulli's equation is not valid for real fluid flow

   Which of these statements are correct?

   (A) 1, 2 and 3   (B) 1 and 2 only   (C) 2 and 3 only   (D) 1 and 3 only

Ans: (d)

67. For an irrotational motion

   (A) The fluid element does not undergo any shear

   (B) The fluid particles do not undergo a circular motion

   (C) The circulation around any path is zero

   (D) The viscosity may not be zero

Ans: (c)

68. The flow past the cylinder with the vertex motion causes a net transverse motion. This transverse force is known as

   (A) Magnus effect   (B) Robins effect

   (C) D'Alembert's Paradox   (D) Rankline doublet

Ans: (a)

69. The conditions in which Bernoull's equation applies are

   1. The flow must be inviscid

   2. The fluid may be compressible or incompressible.

   3. The flow must be steady

   4. There should be only one stream line in the flow

   (A) 1, 2, 3 and 4   (B) 1, 2 and 3 only

   (C) 1, 3 and 4 only   (D) 2, 3 and 4 only

Ans: (b)

70. A pump, having an efficiency of 90%, lifts water to a height of 155 m at the rate of 7.5 m^3/s. The required pump power, in kW, will be

   (A) 13,730   (B) 1,373   (C) 137.3   (D) 13.73

Ans: (b)

71. Match List I with List II and select the correct answer using the code given below the lists :

List I	List II
A. Rotameter	1. Vena contracta
B. Venturimeter	2. Tapering tube
C. Orifice-meter	3. Convergent divergent

D. Flow nozzle   4. Bell mouth entry
Code:
                A   B   C   D   A   B   C   D
        (a)   4   3   1   2   (b)   2   3   1   4
        (c)   4   1   3   2   (d)   2   1   3   4

Ans: (b)

72. Which one of the following instruments is a rate meter ?
    (A) Disk meter   (B) Hot wire anemometer
    (C) Pitot tube   (D) Venturimeter
Ans: (d)

73. Navier – stokes equations are useful in the analysis of
    (A) Turbulent flows   (B) Vortex flows
    (C) Viscous flows   (D) Rotatioal flows
Ans: (c)

74. In a experiment to determine the rheological behaviour of a material, the observed
    relation between shear stress, τ, and rate of shear strain, $\dfrac{du}{dy}$, is $\tau = \tau_0 + c\left(\dfrac{du}{dy}\right)^{0.5}$. The
    material is
    (A) A Newtonian fluid   (B) A thixotropic substance
    (C) A Binghan plastic   (D) An ideal plastic
Ans: (b)

75. The measurement of flow rate in a pipe-is done by a combination of venturimeter and
    (A) V-notch   (B) Pitot tube   (C) Orifice-meter   (D) Manometer
Ans: (d)

76. The loss of head due to sudden enlargement is attributed to
    (A) Viscosity of fluid   (B) Generation of heat
    (C) Roughness of pipe   (D) Production and dissipation of turbulent energy
Ans: (d)

77. A thin plate has been placed parallel to flow direction. The relative magnitude of friction
    and pressure drags will be
    (A) Negligible friction as well as pressure drag
    (B) Negligible pressure drag and maximum friction drag
    (C) Maximum pressure drag and negligible friction drag
    (D) Pressure drag equals the friction drag
Ans: (b)

78. For laminar flow through a pipe, the discharge varies
    (A) Linearly as the diameter   (B) Inversely as the square of diameter
    (C) As the inverse of viscosity   (D) Inversely as the pressure gradient
Ans: (c)

79. Match List I with List II and select the correct answer using the code given below the lists:

List I	List II
A. Coaxial cylinder viscometer	1. Hagen Poiseuille equation
B. Capillary tube viscometer	2. Stokes law
C . Saybolt viscometer	3. Newton's law of viscosity
D. Falling sphere viscometer	4. Efflux viscometer

Codes :

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

Ans: (d)

80. When air is adiabatically saturated, the temperature attained is the
   (A) Dew point temperature
   (B) Dry bulb temperature
   (C) Wet bulb temperature
   (D) Apparatus Dew-point temperature

Ans: (c)

81. For a given discharge in a channel at critical depth
   (A) The specific energy is minimum   (B) The specific energy is maximum
   (C) The total energy is minimum   (D) The total energy is maximum

Ans: (a)

82. Flow takes place at Reynolds number of 1500 in two different pipes with relative roughness of 0.001 and 0.002. The friction factor
   (A) Will be higher in case of pipe with relative roughness of 0.001
   (B) Will be higher in case of pipe with relative roughness of 0.002
   (C) Will be same in both pipes
   (D) In the two pipes cannot be compared on the basis of data given

Ans: (c)

83. Weber number is ratio of square root of inertia force to
   (A) Surface tension force   (B) Gravity force
   (C) Pressure force   (D) Viscous force

Ans: (a)

84. What is the correct statement regarding normal shock wave in a gas ?
   (A) Normal shock is reversible
   (B) The downstream flow as well as uptstream flow is supersonic
   (C) The entropy increases across the shock
   (D) The entropy remains constant

Ans: (c)

85. Across a normal shock
   (A) The pressure and temperature rise   (B) The density and temperature decrease

(C) The velocity and pressure increase   (D) The velocity and pressure decresase

Ans: (a)

86. Air vessels are used in reciprocating pumps in order to
    (A) Increase the delivery head   (B) Reduce suction head
    (C) Minimize delivery head fluctuation   (D) Reduce accelerating head

Ans: (d)

87. A reciprocating water pump delivers 100 litres of water per second against a suction head
    of 5 m and a delivery head of 15 m. The required to drive the pump is near about
    (A) 10 kW   (B) 15 kW   (C) 20 kW   (D) 25 kW

Ans: (c)

88. In a reaction turbine
    (A) It is possible to regulate the flow without loss
    (B) It must be placed at the foot of the fall and above the tail race
    (C) Work done is purely by the change in the kinetic energy of the jet
    (D) Only part of the head is converted into velocity before the water enters the wheel.

Ans: (d)

89. A Kaplan turbine is a
    (A) Outward flow reaction turbine   (B) Inward flow impulse turbine
    (C) Low head axial flow turbine   (D) High head mixed flow turbine

Ans: (c)

90. Which of the following hydraulic turbines are reaction turbines ?
    1. Francis
    2. Kaplan
    3. Propeller
    (A) 1, 2 and 3   (B) 1 and 2 only   (C) 2 and 3 only   (D) 1 and 3 only

Ans: (a)

91. In modern generator, the correct path of gases from boiler furnace to chimney is
    (A) Boiler   furnace,   Economizer,   Air preheater, Superheater and Chimney
    (B) Boiler   furnace,   Superheater,   Air preheater, Economizer and Chimney
    (C) Boiler   furnace,   Air   preheater,   superheater, Economizer and Chimney
    (D) Boiler   furnace,   Superheater, Economizer, Air preheater and Chimney

Ans: (d)

92. Clapeyron's equation is used for finding out the
    (A) Dryness fraction of steam only
    (B) Entropy of superheater vapour only
    (C) Specific volume at any temperature and pressure
    (D) Total heat of superheated steam only

Ans: (c)

93. In a locomotive boiler, the draught is produced by
    (A) Chimnay   (B) ID fan   (C) FD fan   (D) Steam jet

Ans: (d)

94. Out of the following impurities generally found in water, which one requires special consideration in case of very high pressure boilers ?
    (A) Hydrogen   (B) Ammonia   (C) Silica   (D) Dissolved salts
Ans: (d)

95. Willans line represents
    (A) Total steam consumption vs power output with throttle governing
    (B) Total steam consumption vs power output with cutoff governing
    (C) Behaviour of supersaturated steam through nozzles
    (D) Condensation of steam while flowing through the turbine
Ans: (a)

96. Consider the following statements for an incompressible fluid flowing through a convergent-divergent duct :
    1. The convergent part acts as a nozzle
    2. The divergent part acts as a diffuser
    3. The maximum limiting speed of the fluid is the sonic velocity
    Which of these statements are-correct ?
    (A) 1, 2 and 3   (B) 1 and 2 only   (C) 2 and 3 only   (D) 1 and 3 only
Ans: (b)

97. An isentropic nozzle is discharging steam through critical pressure ratio. If the back pressure is further decreased, the discharge will
    (A) Decrease   (B) Increase
    (C) Remain unaffected   (D) Come to a dead stop due to shock waves
Ans: (c)

98. State of a wet vapour cannot be specified only by
    (A) Pressure and temperature   (B) Pressure and dryness fraction
    (C) Temperature and dryness fraction   (D) Pressure and volume
Ans: (a)

99. Pertaining to a steam boiler, which of the following statements is correct ?
    (A) Primary boiler heat transfer surface includes evaporator section, economizer and air preheater
    (B) Primary boiler heat transfer surface includes evaporator section, economizer and superheater section
    (C) Secondary boiler heat transfer surface includes superheater, economizer and air preheater
    (D) Primary boiler heat transfer surface includes evaporator section, superheater section and reheat section
Ans: (c)

100. Which of the following statements is not correct for the volumetric efficiency of a reciprocating air compressor ?
    (A) It decreases with increase in ambient temperature
    (B) It increases with decrease in pressure ratio
    (C) It increases with decrease in clearance raio
    (D) It decreases with increase in delivery pressure

Ans: (d)

101. In a single stage reciprocating air compressor, the work done on air to compress it from suction pressure to delivery pressure will be minimum when the compression is
    (A) Isothermal process   (B) Adiabatic process
    (C) Polytropic process   (D) Constant pressure process
Ans: (a)

102. In an axial flow compressor, stalling is the phenomenon of
    (A) Air motion at sonic velocity (B) Air stream blocking the passage
    (C) Reversed flow of air   (D) Air stream not following the blade countour
Ans: (d)

103. In Rayleigh flow at subsonic Mach numbers, heat addition
    (A) Decreases static pressure   (B) Decreases enthalpy
    (C) Increases static pressure   (D) Decreases static temperature
Ans: (a)

104. The function of economizer in a boiler is to
    (A) Superheat the steam   (B) Reduce fuel consumption
    (C) Increase steam pressure   (D) Maintain saturation temperature
Ans: (b)

105. In which modification of simple gas turbine cycle, is work ratio increased ?
    1. Regenerative gas turbine cycle
    2. Gas turbine cycle with reheating
    (A) Both 1 and 2   (B) 1 only   (C) 2 only   (D) Neither 1 nor 2
Ans: (c)

106. Reheat between multi-stage expansions in joule cycle increases
    1. Overall work output   2. The work ratio   3. The thermal efficiency
    Which of the above are correct ?
    (A) 1, 2 and 3   (B) 1 and 2 only   (C) 2 and 3 only   (D) 1 and 3 only
Ans: (b)

Directions : Each of the next fourteen (14) items consists of two statements, one labeled as the 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :
    Codes :
    (A) Both A and R are individually true and R is the correct explanation of A
    (B) Both A and R are individually true but R is not the correct explanation of A
    (C) A is true but R is false
    (D) A is false but R is true

107. Assertion (A) : In SI engines higher compression ratio induces knocking
    Reason   (R) : Higher compression ratio increases the temperature of the end mixture
Ans: (a)

108. Assertion (A) : In fluid system model studies, a simple scaling-up of measurements made on the model may not yield results accurately corresponding to the prototype
     Reason   (R) : Surface tension forces may be relatively much more significant in the model than in the prototype

Ans: (b)

109. Assertion (A) : In non-Newtonian fluids, the shear stress at any point is not a linear function of normal distance from the surface
     Reason   (R) : This behaviour usually arises because the fluid molecules are very large, like polymers or proteins

Ans: (a)

110. Assertion (A) : The mercury level inside the tube shall rise above the level of mercury outside
     Reason   (R) : The cohesive force between the molecules of mercury is greater than the

Ans: (d)

                    adhesive force between mercury and glass
111. Assertion (A) : At great depth, the vertical distance between the centre of pressure and the centre of area of immersed surface becomes negligible
     Reason   (R) : The depth of centre of pressure of any immersed surface is independent of the density of the liquid

Ans: (b)

112. Assertion (A) : Increasing the meta-centric height gives greater stability, but reduces the period of roll, so that the vessel is less comfortable for passengers
     Reason   (R) : Warships and racing yachts have larger meta-centric height as their stability is more important than comfort.

Ans: (a)

113. Assertion (A) : After the fluid downstream of the orifice plate has re-established it will return to the same pressure that it had upstream of the orifice plate.
     Reason   (R) : According to Bernoulli's theorem with usual assumptions, the flow between two points, the sum of kinetic, potential and pressure energies remain constant

Ans: (d)

114. Assertion (A) : In a Rayleigh flow of subsonic compressiable flow heating causes the Mach number to reach a maximum of 1; but the static temperature at this point is less than that due to frictional effects alone
     Reason   (R) : This is due to extra storage of heat energy as internal energy

Ans: (c)

115. Assertion (A) : In centrifugal compressors, sometimes guide vanes are provided at inlet
     Reason   (R) : The guide vanes provide restricting the Mach number at inlet to an acceptable value, below supersonic

Ans: (a)

116. Assertion (A) : In steam turbines, supersaturated flow means that the vapour does not condense immediately as it crosses the dry saturated line

Reason (R) : The mass flow with supersaturation flow is greater than the mass flow with isentropic flow

Ans: (a)

117. Assertion (A) : In a modern coal burning steam generator, the temperature of exiting flue gases from the chimney should be below 100º C

   Reason (R) : The lower the temperature of exiting flue gases from the chimney, higher is the heat recovery and therefore higher the efficiency of the steam generator

Ans: (d)

118. Assertion (A) : A draft tube is used to reduce the pressure at the runner exit in order to get the increased value of working tail race

   Reason (R) : A portion of the exit kinetic energy is recovered which otherwise goes waste to the tail race

Ans: (c)

119. Assertion (A) : A major shortcoming of a fire-tube boiler is that the maximum size of the unit and the maximum operating pressure are limited

   Reason (R) : Both large diameters and high pressure lead to prohibitively thick shells resulting in very high cost

Ans: (b)

120. Assertion (A) : The pressure compounded impulse steam turbine is the most efficient type of impulse turbine

   Reason (R) : It is because the ratio of blade velocity to steam velocity remains constant

Ans: (b)