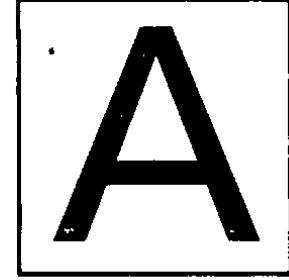


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T.B.C. : Q-GUG-K-NFA

Test Booklet Series

Serial No 036741



TEST BOOKLET

MECHANICAL ENGINEERING

PAPER I

Time Allowed : Two Hours

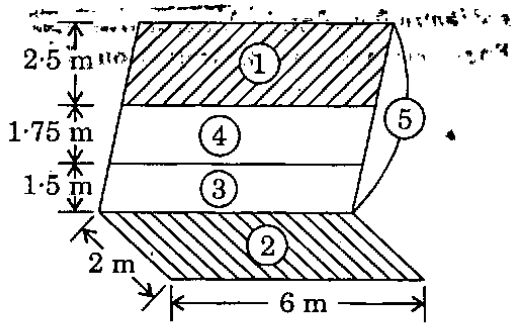
Maximum Marks : 200

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 responses **ONLY** on the separate Answer Sheet provided. See directions 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 take 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.

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1.



With reference to the above figure, the shape factor between 1 and 2 is

- (a) 0.272
- (b) 0.34
- (c) 0.66
- (d) data insufficient

2.

A jet of oil with relative density 0.7 strikes normally a plate with a velocity of 10 m/s. The jet has an area of 0.03 m^2 . The force exerted on the plate by the jet is

- (a) 210 N
- (b) 2.1 kN
- (c) 20.6 kN
- (d) 206 N

3.

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

<u>List I</u>	<u>List II</u>
A. Lubrication	1. Capillary
B. Rise of sap in trees	2. Vapour pressure
C. Formation of droplets	3. Viscosity
D. Cavitation	4. Surface tension

Code :

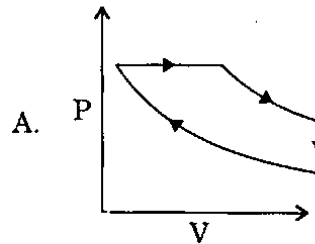
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
(a)	2	4	1	3
(b)	3	4	1	2
(c)	2	1	4	3
(d)	3	1	4	2

4.

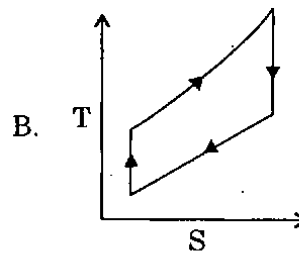
Match List I with List II and select the correct answer using the code given below the lists :

List I

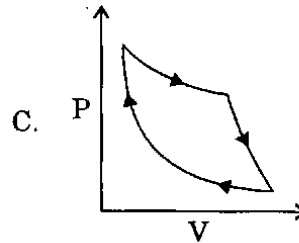
List II



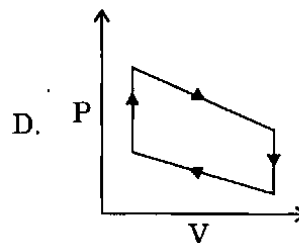
1. Diesel cycle



2. Carnot cycle



3. Brayton cycle



4. Otto cycle

Code :

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
(a)	4	2	3	1
(b)	1	2	3	4
(c)	4	3	2	1
(d)	1	3	2	4

5. Consider the following statements regarding Bernoulli's theorem for fluid flow :

1. Conservation of energy
2. Steady flow
3. Viscous flow
4. Incompressible flow

Which of the above statements is/are correct ?

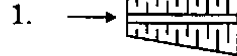
- (a) 1, 2 and 4 only
- (b) 1 only
- (c) 2, 3 and 4 only
- (d) 1, 2, 3 and 4

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

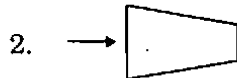
List I

List II

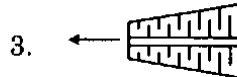
A. Steam turbine



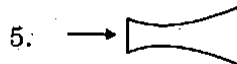
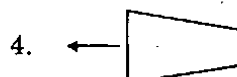
B. Subsonic diffuser



C. Supersonic nozzle



D. Axial flow compressor



Code :

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

7. The parameters which determine the friction for turbulent flow in a rough pipe are

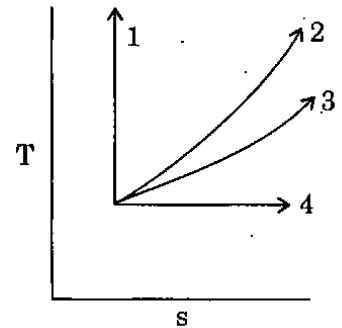
- (a) Froude number and relative roughness
- (b) Froude number and Mach number
- (c) Reynolds number and relative roughness
- (d) Mach number and relative roughness

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

List I
(Process index 'n')

List II
(T-s traces)

- A. 0
- B. 1-0
- C. 1-4
- D. ∞



Code :

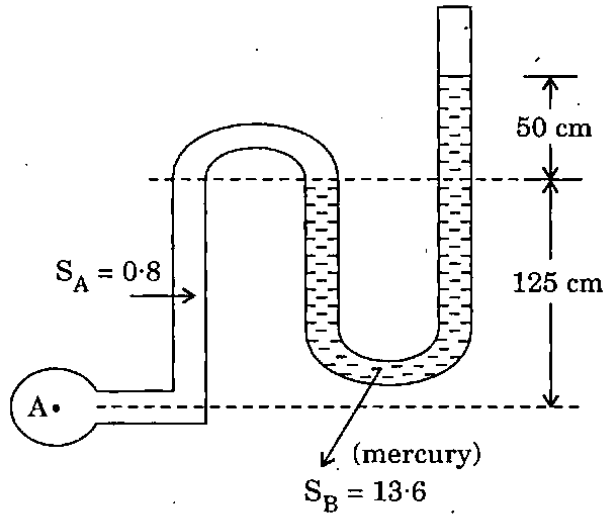
	A	B	C	D
(a)	3	1	4	2
(b)	2	1	4	3
(c)	3	4	1	2
(d)	2	4	1	3

9. For designing air-conditioning ducts, equal friction method

- (a) Ensures same velocity in the duct all through in all branches
- (b) Ensures constant static pressure at all terminals in the duct
- (c) Automatically reduces the air-velocity in the duct in the direction of flow
- (d) Does all of the above

10. An oil of kinematic viscosity 0.5 stoke is flowing through a pipe of 5 cm diameter. The flow through the pipe becomes critical at a velocity of
- 0.2 m/s
 - 2 m/s
 - 2.5 m/s
 - 4 m/s
11. Which one of the following statements is *not* correct ?
In a transient flow process
- The rates of inflow and outflow of mass are different
 - The state of matter inside the control volume varies with time
 - There can be heat and work interactions across the control volume
 - There is no accumulation of energy inside the control volume
12. Detonation in the S.I. engine becomes severe during
- Low load and high speed
 - High load and high speed
 - Low load and low speed
 - High load and low speed
13. The head loss in a sudden expansion from 6 cm diameter pipe to 12 cm diameter pipe in terms of velocity V_1 in the smaller diameter pipe is
- $\frac{3}{16} \cdot \frac{V_1^2}{2g}$
 - $\frac{5}{16} \cdot \frac{V_1^2}{2g}$
 - $\frac{7}{16} \cdot \frac{V_1^2}{2g}$
 - $\frac{9}{16} \cdot \frac{V_1^2}{2g}$
14. Consider the following statements regarding turbulent boundary layer on a flat plate with zero pressure gradient :
- The thickness of the boundary layer increases approximately as the power of the distance from the leading edge.
 - The shear stress at the boundary is approximately inversely proportional to the square root of the local Reynolds number.
- Which of the above statements is/are correct ?
- Both 1 and 2
 - Neither 1 nor 2
 - 1 only
 - 2 only
15. Air (density 1.2 kg/m³ and kinematic viscosity 15 centistokes) flows over a flat plate, at zero angle of incidence, at a velocity of 20 m/s. If Reynolds number at transition is taken as 2.5×10^5 , maximum distance, from leading edge up to which the boundary layer remains laminar, is
- 375 mm
 - 93.75 mm
 - 187.5 mm
 - 250 mm

16.



(Where S_A and S_B are the specific gravities of the two fluids)

What is the absolute pressure at A measured by an open tube manometer as in the figure above? Assume atmospheric pressure as 103 kN/m^2 .

- (a) 78.5 kN/m^2
- (b) 180 kN/m^2
- (c) 1030 kN/m^2
- (d) 103 kN/m^2

17. The discharge, over a rectangular weir of width 100 m when the head of water over the weir is 1.5 m and the head due to velocity of approach is 0.02 m, is given by

- (a) $842.5 \text{ m}^3/\text{s}$
- (b) $653.4 \text{ m}^3/\text{s}$
- (c) $814.5 \text{ m}^3/\text{s}$
- (d) $552.5 \text{ m}^3/\text{s}$

18. In similitude with gravity force, where equality of Froude number exists, the velocity ratio becomes

- (a) 1.0
- (b) $(L_r)^{1/2}$
- (c) $1/L_r$
- (d) $(L_r)^{3/2}$

Where L_r = ratio of model to prototype linear dimension.

19. The velocity potential function is given by an expression $\phi = -\frac{xy^3}{3} - x^2 + \frac{x^3y}{3} + y^2$. The velocity component in x direction is

- (a) $xy^2 - \frac{x^3}{3} - 2y$
- (b) $\frac{y^3}{3} + 2x - x^2y$
- (c) $3x^2y + 2x - xy^2$
- (d) $x^3y^2 + 2x^2 - y^2x$

20. A refrigerated van has to be maintained at -10°C , while ambient temperature is 32°C . Overall surface area of the van is 25 m^2 . The walls of the van are of 16 mm plywood ($k = 0.06 \text{ W/m.K}$) at inner surface and 12 mm of glass work ($k = 0.06 \text{ W/m.K}$). The capacity of the refrigerated van in tons of refrigeration will be

- (a) 0.10 ton
- (b) 0.35 ton
- (c) 0.55 ton
- (d) 0.65 ton

21. The velocity potential in a flow field is $\phi = 2xy$. The corresponding value of stream function is
- $(y^2 - x^2) + \text{constant}$
 - $(x^2 - y^2) + \text{constant}$
 - $\frac{1}{2}(x^2 - y^2) + \text{constant}$
 - $2(x - y) + \text{constant}$
22. As an index of comfort, the temperature of saturated air at which a person would experience the same feeling of comfort as experienced in the actual unsaturated environment is called the
- Comfort temperature
 - Effective temperature
 - Wet bulb temperature
 - Soothing temperature
23. When moist air passes through a bed of silica gel, the
- Dry bulb temperature of air decreases
 - Dry bulb temperature of air increases
 - Specific humidity of air increases
 - It undergoes adiabatic saturation
24. Stream and velocity potential functions for a 2D flow field given by $u = 2x$ and $v = -2y$ are
- $\psi = 2xy, \phi = x^2 - y^2$
 - $\psi = x^2 - y^2, \phi = 2xy$
 - $\psi = x^2y^2, \phi = x^2 + y^2$
 - $\psi = x^2 + y^2, \phi = x^2y^2$
25. The stream function in a two-dimensional flow field is given by $\psi = x^2 - y^2$. Then the magnitude of velocity at point (1, 1) is
- 2
 - $2\sqrt{2}$
 - 4
 - 8
26. In air-water vapour mixture, the partial pressure of water vapour corresponds to the saturation temperature called
- Dew point temperature
 - Wet bulb temperature
 - Dry bulb temperature
 - Adiabatic saturation temperature
27. Consider the following :
- The components of velocity u and v along X and Y directions in a 2D flow problem of an incompressible fluid are
- $u = x^2 \cos y; v = -2x \sin y$
 - $u = x + 2; v = 1 - y$
 - $u = xyt; v = x^3 - y^2t/2$
 - $u = \ln x + y; v = xy - y/x$
- Which of these will satisfy the continuity equation ?
- 1, 2 and 3 only
 - 1, 2 and 4 only
 - 2, 3 and 4 only
 - 1, 2, 3 and 4

28. Moderator in a nuclear plant is used to
- Protect against neutron and gamma rays
 - Absorb excess neutrons
 - Slow down the speed of fast moving neutrons
 - Return the neutrons back into the core of the reactor
29. A certain air has DBT of 35°C and DPT of 20°C , the corresponding saturation pressure of water being 5.628 kPa and 2.33 kPa respectively. When the atmospheric pressure is assumed as 1.0132 bar, the specific humidity of air will be
- 2.5×10^{-3}
 - 7.8×10^{-3}
 - 14.7×10^{-3}
 - 25×10^{-3}
30. The effects of superheating of vapour in the evaporator and sub cooling of condensate in the condenser, for the same compressor work
- Increase the COP
 - Decrease the COP
 - Superheating increases COP, but sub cooling decreases COP
 - Superheating decreases COP, but sub cooling increases COP
31. The components of rotation for a three-dimensional flow field $V = (y^2 + z^2)\hat{i} + (x^2 + z^2)\hat{j} + (x^2 + y^2)\hat{k}$ at (1, 2, 3) are
- $w_x = -1 \text{ rad/s}, w_y = 2 \text{ rad/s}, w_z = -1 \text{ rad/s}$
 - $w_x = -1 \text{ rad/s}, w_y = -1 \text{ rad/s}, w_z = 2 \text{ rad/s}$
 - $w_x = -2 \text{ rad/s}, w_y = -1 \text{ rad/s}, w_z = -2 \text{ rad/s}$
 - $w_x = 2 \text{ rad/s}, w_y = -2 \text{ rad/s}, w_z = -1 \text{ rad/s}$
32. The higher calorific value of fuel occurs when water vapour
- Present in products of combustion is condensed to the initial temperature of the fuel
 - Present in products of combustion is not condensed to the initial temperature of the fuel
 - Is not formed during combustion of a fuel
 - Is formed during combustion of a fuel
33. The vapour compression refrigeration cycle is an inherently irreversible cycle, because
- The compressor is non-ideal
 - The evaporator is not frictionless
 - The condensation process is not isothermal
 - Of the use of expansion valve instead of an expansion engine
34. The Stoichiometric air-fuel ratio by volume for combustion of carbon monoxide in air is
- 1.19
 - 2.38
 - 2.45
 - 4.76

35. A 50 cm diameter spherical vessel is completely filled up with a liquid of specific gravity 0.8; the vessel and the liquid are then rotated about the vertical axis, without relative motion, at a rotational speed of 20 rad/s. The points of maximum pressure lie on a horizontal plane below the centre of sphere by

- (a) 12.5 cm
- (b) 6.96 cm
- (c) 2.45 cm
- (d) 1.96 cm

36. Consider the following :

- 1. EGR
- 2. Increased compression ratio.
- 3. Thermal reactor in the exhaust manifold.
- 4. Use of 5% lean mixture.

Which of these are used to control NO_x emission from engine exhaust ?

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

37. A refrigerator operates between the temperatures of -23°C and 27°C . If one TR = 3.5 kW, the minimum power required per TR to operate the refrigerator is

- (a) 0.5 kW
- (b) 0.7 kW
- (c) 0.9 kW
- (d) 1.0 kW

38. Consider the following :

- 1. Catalytic converter.
- 2. Use of high compression ratio.
- 3. Oxidation catalyst in the exhaust manifold.
- 4. Use of high degree of supercharger.

By which of these techniques, can the oxides of nitrogen in the engine exhaust be controlled ?

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

39. Consider the following statements :

- 1. Piezometer is used to measure small variation of pressure above or below ambient pressure.
- 2. Thixotropic fluid exhibits decrease in viscosity with time.

Which of the above statements is/are correct ?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

40. The main object of Morse test is to find out

- (a) Performance of a petrol engine
- (b) Performance of a diesel engine
- (c) Frictional power of a petrol engine
- (d) Indicated power of a single cylinder diesel engine

41. Which phenomena have the most adverse effect on volumetric efficiency when engine works at high speeds ?
- Flow friction and choking
 - Ram effect and choking
 - Flow friction and charge heating
 - Charge heating and back flow
42. In rocket propulsion, the oxygen for combustion of its fuel is taken from
- Surrounding air
 - The rocket itself
 - Compressed atmospheric air
 - Surrounding air and compressed atmospheric air
43. A body will be in a stable equilibrium in a floating condition if
- The metacentre is below the centre of gravity
 - The metacentre is above the centre of gravity
 - The metacentric height is zero
 - The centre of buoyancy coincides with the centre of gravity
44. Consider the following :
- Increased cetane number.
 - Increased compression ratio.
 - Increased injection advance.
 - Increased air turbulence.
- Which of the above factors reduce physical delay in the diesel engine ?
- 1, 2 and 3 only
 - 2 and 4 only
 - 2, 3 and 4 only
 - 1, 2, 3 and 4
45. Consider the following statements :
- Increasing the metacentric height of a ship causes increase in the period of rolling.
 - The frequency of pitching can be reduced by adding more loads along the length of a ship below its centre of gravity.
 - A ship has different metacentres in rolling and pitching.
 - Stability can be improved by increasing the width and reducing the draft.
- Which of the above statements are correct ?
- 1, 2, 3 and 4
 - 1, 2 and 4 only
 - 1, 2 and 3 only
 - 2, 3 and 4 only
46. Consider the following factors :
- Diesel engine knock can be reduced by increasing
- Engine speed.
 - Compression ratio.
 - Degree of supercharge.
 - Injection advance.
- Which of the above statements is/are correct ?
- 1, 2, 3 and 4
 - 2 and 3 only
 - 1, 3 and 4 only
 - 2 only
47. An ideal refrigerator is operating between a condenser temperature of 37°C and an evaporator temperature of -3°C . If the machine is functioning as a heat pump, its coefficient of performance will be
- 6.00
 - 6.75
 - 7.00
 - 7.75

48. Two radiating surfaces $A_1 = 6 \text{ m}^2$ and $A_2 = 4 \text{ m}^2$ have the shape factor $F_{1-2} = 0.1$; the shape factor F_{2-1} will be

- (a) 0.18
- (b) 0.15
- (c) 0.12
- (d) 0.10

49. Consider the following statements regarding SI engine :

- 1. Specific output is higher than CI engine.
- 2. It can burn leaner mixtures than CI engine.
- 3. For a given volumetric capacity, its power output is lesser than CI engine.
- 4. Its exhaust pollution is higher relative to CI engine.

Which of the above statements is/are correct ?

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

50. Consider the following statements regarding a CI engine :

- 1. CI engine knock can be reduced by increasing compression ratio.
- 2. Thermal efficiency of a CI engine is lower relative to a SI engine.
- 3. CI engine has a higher specific output relative to SI engine.
- 4. CI engines use leaner mixtures relative to SI engines.

Which of the above statements are correct ?

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

51. Consider the following statements related to the stability of floating bodies :

- 1. The metacentre should be above the centre of gravity of the floating body for stable equilibrium during small oscillations.
- 2. For a floating body, stability is not determined simply by the relative positions of centre of gravity and centre of buoyancy.
- 3. The position of metacentre of a floating body is fixed irrespective of the axis of oscillations.
- 4. Large value of metacentric height reduces the period of roll of the vessel.

Which of the above statements are correct ?

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

52. Consider the following statements :

- 1. $P_2 = \frac{P_1 + P_3}{2}$
- 2. $P_2 = \sqrt{P_1 P_3}$
- 3. Intercooling is perfect.
- 4. Work in the LP cylinder is twice the work in the HP cylinder.

Which of the above statements are correct for maximum compression efficiency in a 2-stage compressor ?

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

53. Consider the following statements :

1. Static pressure increases.
2. Stagnation pressure decreases.
3. Static temperature increases.
4. Stagnation temperature decreases.

Which of the above statements are correct for change in properties across normal shock wave ?

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

54. Consider the following statements :

1. A small bubble of one fluid immersed in another fluid has a spherical shape.
2. The droplets of a fluid move upward or downward in another fluid due to unbalance between gravitational and buoyant forces.
3. Droplets of bubbles attached to a solid surface can remain stationary in a gravitational fluid if the surface tension exceeds buoyant forces.
4. Surface tension of a bubble is proportional to its radius while buoyant force is proportional to the cube of its radius.

Which of the above statements are correct ?

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

55. A Carnot heat pump works between temperature limits of 277°C and 27°C . Its COP is

- (a) 1.108
- (b) 1.2
- (c) 2.2
- (d) 9.26

56. The radiative heat transfer rate per unit area (W/m^2) between two plane parallel grey surfaces whose emissivity is 0.9 and maintained at 400 K and 300 K is

- (a) 992
- (b) 812
- (c) 567
- (d) 464

57. Efficiency of a Carnot engine is 75%. If the cycle direction is reversed, COP of the reversed Carnot cycle is

- (a) 1.33
- (b) 0.75
- (c) 0.33
- (d) 1.75

58. Consider the following :

1. Kinetic energy
2. Entropy
3. Thermal conductivity
4. Pressure

Which of these are intensive properties ?

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

59. For film-wise condensation on a vertical plane, the film thickness δ and heat transfer coefficient h vary with distance x from the leading edge as

- (a) δ decreases, h increases
- (b) Both δ and h increase
- (c) δ increases, h decreases
- (d) Both δ and h decrease

60. Molal specific heats of an ideal gas depend on

- (a) Its pressure
- (b) Its temperature
- (c) Both its pressure and temperature
- (d) The number of atoms in a molecule

61. Consider the following statements :

1. Mass transfer refers to mass in transit due to a species concentration gradient in a mixture.
2. Must have a mixture of two or more species for mass transfer to occur.
3. The species concentration gradient is the driving potential for mass transfer.
4. Mass transfer by diffusion is analogous to heat transfer by conduction.

Which of the above statements are correct ?

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

62. Consider the following :

1. Temperature
2. Viscosity
3. Internal energy
4. Entropy

Which of these are extensive properties ?

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

63. The centre of buoyancy is

- (a) Centre of gravity of the body
- (b) Point of intersection of the buoyant force and the gravitational force
- (c) Point of intersection of the buoyant force and the centre line of the body
- (d) Centre of the volume of the displaced fluid

64. Consider the following statements :

1. Boiling of water from a heat source at the same boiling temperature.
2. Theoretical isothermal compression of a gas.
3. Theoretical polytropic compression process with heat rejection to atmosphere.
4. Diffusion of two ideal gases into each other at constant pressure and temperature.

Which of these processes are irreversible ?

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

65. A circular area of 1.2 m diameter is immersed vertically in a liquid of unit weight 800 N/m^3 with its top edge just on the liquid surface. The depth of centre of pressure on one side, measured below the liquid surface, is

- (a) 0.80 m
- (b) 0.75 m
- (c) 0.60 m
- (d) 0.64 m

66. The following statements refer to axial flow compressors as compared to centrifugal compressors :

1. Can be designed for higher pressure ratios than centrifugal compressors.
2. Maximum efficiency higher than centrifugal compressors but in a narrow speed range.
3. More suitable for aviation gas turbines due to lower frontal area.
4. Lighter in mass than centrifugal compressors.

Which of the above statements are correct ?

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

67. Consider the following statements !
1. Slow heating of water from an electric heater.
 2. Isentropic expansion of air.
 3. Evaporation of a liquid from a heat source at the evaporation temperature.
 4. Constant pressure heating of a gas by a constant temperature source.

Which of these processes is/are reversible ?

- (a) 3 only
 - (b) 2 and 3 only
 - (c) 2 and 4 only
 - (d) 1, 2, 3 and 4
68. A curved surface has the shape of one-quadrant of a 3 m long 2 m diameter cylinder with two edges parallel to the axis. The curved surface is immersed in a stationary liquid of unit weight 10 kN/m^3 such that one straight edge is on the liquid surface and the other 1 m below the surface. The moment of vertical component of hydrostatic thrust on one side of the surface, about the axis of circular arc, is
- (a) 7.854 kNm
 - (b) 10.0 kNm
 - (c) 11.781 kNm
 - (d) 15.708 kNm
69. For a balanced counter-flow heat exchanger, the temperature profiles of the two fluids are
- (a) Parallel and non-linear
 - (b) Parallel and linear
 - (c) Linear but non-parallel
 - (d) Divergent from one another

70. A Carnot engine rejects 30% of absorbed heat to a sink at 30°C . The temperature of the heat source is
- (a) 100°C
 - (b) 433°C
 - (c) 737°C
 - (d) 1010°C

71. If a fluid flows through a capillary tube of length L and diameter D , and the mass flow rate and the pressure drop are measured, the viscosity of the fluid can be estimated from the
- (a) Euler equation
 - (b) Bernoulli's equation
 - (c) Hagen-Poiseuille equation
 - (d) Dittus-Boelter equation

72. An engine operates between temperature limits of 900 K and T_2 and another between T_2 and 400 K . For both to be equally efficient, the value of T_2 will be
- (a) 700 K
 - (b) 600 K
 - (c) 750 K
 - (d) 650 K

73. The tube of an inclined tube manometer has its upper end open to air and the lower end connected to a vertical cylinder trough having a diameter 4 times that of the tube. The slope of the tube is 1 in 4 and specific gravity of manometer liquid is 0.72. The space above the liquid in the trough is connected to a gas chamber. When the movement of meniscus in the tube is 8 cm, change in gas pressure, in height of water column, is
- (a) 1.35 cm
 - (b) 1.44 cm
 - (c) 1.80 cm
 - (d) 1.53 cm

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

List I
(Losses)

List II
(Parameters responsible)

- | | |
|------------------|---|
| A. Leakage loss | 1. Zero at design point |
| B. Friction loss | 2. Proportional to head |
| C. Entrance loss | 3. Proportional to half of relative velocity square |

Code :

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

75. In a heat exchanger, the hot liquid enters with a temperature of 180°C and leaves at 160°C. The cooling fluid enters at 30°C and leaves at 110°C. The capacity ratio of the heat exchanger is

- (a) 0.25
- (b) 0.40
- (c) 0.50
- (d) 0.55

76. The Zeroth law of thermodynamics states that

- (a) Two thermodynamic systems are always in thermal equilibrium with each other
- (b) If two systems are in thermal equilibrium, then the third system will also be in thermal equilibrium
- (c) Two systems not in thermal equilibrium with a third system are 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 with each other

77. On heat transfer surface, fins are provided

- (a) To increase temperature gradient so as to enhance heat transfer
- (b) To increase turbulence in flow for enhancing heat transfer
- (c) To increase surface area to promote the rate of heat transfer
- (d) To decrease the pressure drop of the fluid

78. The annular space between two co-axial vertical cylinders, of equal length, is filled with an incompressible liquid of constant viscosity. The outer cylinder is held fixed and the inner cylinder is slowly rotated about its axis at a uniform rotational speed. Assuming that Newton's law of viscosity holds good

- (a) The tangential velocity of liquid varies linearly across the gap
- (b) Viscous shear stress in liquid is uniform across the gap
- (c) The tangential velocity of liquid varies non-linearly across the gap
- (d) Viscous shear stress in liquid varies linearly across the gap

79. Fins are made as thin as possible to

- (a) Reduce the total weight
- (b) Accommodate more number of fins
- (c) Increase the width for the same profile area
- (d) Improve flow of coolant around the fin

80. Consider the following statements regarding a reciprocating air compressor :

1. The effect of clearance is to reduce the volumetric efficiency.
2. The clearance has no effect on work done per kg of air delivered.
3. The volumetric efficiency decreases with increasing pressure ratio.

Which of the above statements is/are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 3 only

81. An inventor states that his new engine rejects to the sink 40% of heat absorbed from the source while the source and sink temperatures are 327°C and 27°C respectively. His engine is therefore equivalent to

- (a) Joule engine
- (b) Stirling engine
- (c) Impossible engine
- (d) Carnot engine

82. A thin plane lamina, of area A and weight W , slides down a fixed plane inclined to the vertical at an angle α and maintains a uniform gap ε from the surface of the plane, the gap being filled with oil of constant viscosity μ . The terminal velocity of the plane is

- (a) $\frac{\varepsilon \cos \alpha}{\mu W A}$
- (b) $\frac{\varepsilon \mu W}{A \sin \alpha}$
- (c) $\frac{\varepsilon W \cos \alpha}{A \mu}$
- (d) $\frac{\mu W \sin \alpha}{\varepsilon A}$

83. A closed system receives 60 kJ heat but its internal energy decreases by 30 kJ. Then the work done by the system is

- (a) 90 kJ
- (b) 30 kJ
- (c) -30 kJ
- (d) -90 kJ

84. In a two-stage reciprocating air compressor, the suction and delivery pressures are 1 and 4 bar respectively. For maximum efficiency, the intercooler pressure is

- (a) 1.5 bar
- (b) 2.0 bar
- (c) 2.5 bar
- (d) 3.0 bar

85. Consider the following statements :

For a velocity-compounded impulse steam turbine stage having two rows of moving blades

1. The work done in each row of moving blades is equal.
2. The efficiency of a velocity-compounded stage is less than that of a pressure-compounded stage.
3. The velocity-compounded stage is often used in the first stage of a multistage impulse turbine.

Which of the above statements is/are correct ?

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

86. Extended surfaces are used to increase the rate of heat transfer. When the convective heat transfer coefficient $h = mk$, the addition of extended surface will

- (a) Increase the rate of heat transfer
- (b) Decrease the rate of heat transfer
- (c) Not increase the rate of heat transfer
- (d) Increase the rate of heat transfer when the length of the fin is very large

87. Consider the following statements :

For a fluidized bed boiler

- 1. There is less formation of NO_x .
- 2. It can burn inferior grades of coal.

Which of the above statements is/are correct ?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

88. Hot coffee stored in a well insulated thermos flask is an example of

- (a) Isolated system
- (b) Closed system
- (c) Open system
- (d) Non-flow diabatic system

89. In a quiescent sea, density of water at free surface is ρ_0 and at a point much below the surface density is ρ . Neglecting variation in gravitational acceleration g and assuming a constant value of bulk modulus K , the depth h of the point from the free surface is

(a) $\frac{K}{g} \left(\frac{1}{\rho_0} + \frac{1}{\rho} \right)$

(b) $\frac{K}{g} \frac{(\rho - \rho_0)}{(\rho + \rho_0)^2}$

(c) $\frac{K}{g} \left(\frac{1}{\rho_0} - \frac{1}{\rho} \right)$

(d) $\frac{K}{g} \frac{\rho \rho_0}{\rho + \rho_0}$

90. Upto the critical radius of insulation

- (a) Convection heat loss will be less than conduction heat loss
- (b) Heat flux will decrease
- (c) Added insulation will increase heat loss
- (d) Added insulation will decrease heat loss

91. Consider the following statements :

For a supercritical steam generator

- 1. It has no steam drum.
- 2. It has no circulation pump.
- 3. The phenomenon of boiling does not occur in it.

Which of the above statements is/are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 3 only

92. Pseudo plastic is a fluid for which
- (a) Dynamic viscosity decreases as the rate of shear increases
 - (b) Newton's law of viscosity holds good
 - (c) Dynamic viscosity increases as the rate of shear increases
 - (d) Dynamic viscosity increases with the time for which shearing forces are applied
93. A control volume is
- (a) An isolated system
 - (b) A closed system but heat and work can cross the boundary
 - (c) A specific amount of mass in space
 - (d) A fixed region in space where mass, heat and work can cross the boundary of that region
94. The time constant of a thermocouple is
- (a) The time taken to attain 100% of initial temperature difference
 - (b) The time taken to attain 63.2% of initial temperature difference
 - (c) The time taken to attain 50% of initial temperature difference
 - (d) The minimum time taken to record a temperature reading

95. Specific speed of a turbomachine
- (a) Is the speed of a machine having unit dimensions
 - (b) Relates the shape rather than size of machine
 - (c) Remains the same under different conditions of operations
 - (d) Depends only upon the head under which the machine operates
96. Isothermal compression of air in a Stirling engine is an example of
- (a) Open system
 - (b) Steady flow diabatic system
 - (c) Closed system with a movable boundary
 - (d) Closed system with fixed boundary
97. If angle of contact of a drop of liquid is acute then
- (a) Adhesion is more than cohesion
 - (b) Cohesion is more than adhesion
 - (c) Cohesion is equal to adhesion
 - (d) Adhesion and cohesion have no bearing with angle of contact
98. A closed thermodynamic system manifests when
- (a) Matter is not allowed to cross the boundary but energy transfer occurs across the boundary
 - (b) There is transfer of both mass and energy across the system boundaries
 - (c) There is only transfer of mass but no heat and work energy are transferred
 - (d) There is absolutely no interaction of the system with surroundings

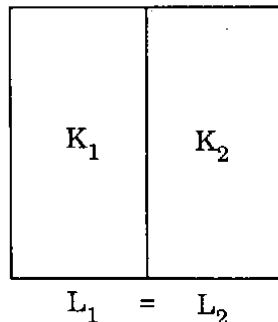
99. Consider the following statements regarding a draft tube used in water turbines :

1. It reduces the discharge velocity of water to minimize the loss of kinetic energy at the outlet.
2. It permits the turbine to be set above the tail race without any appreciable drop in available head.
3. It is used in both impulse and reaction type of water turbines.

Which of the above statements is/are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 1 only

100.



The equivalent thermal conductivity of the wall as shown in the figure above is

- (a) $\frac{K_1 + K_2}{2}$
- (b) $\frac{K_1 K_2}{K_1 + K_2}$
- (c) $\frac{2 K_1 K_2}{K_1 + K_2}$
- (d) $\sqrt{K_1 K_2}$

Directions : Each of the next twenty (20) items consists of two statements, one labelled 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

101. **Assertion (A) :** The constant pressure lines are steeper than the constant volume lines for a perfect gas on the T-S plane.

Reason (R) : The specific heat at constant pressure is more than the specific heat at constant volume for a perfect gas.

102. **Assertion (A) :** In a diesel engine knocking decreases with reduced engine speed.

Reason (R) : With increased engine speed, quantity of fuel injected during the delay period increases.

103. **Assertion (A) :** Rocket engines are used for space research.

Reason (R) : They have high specific impulse.

104. *Assertion (A)* : Lumped capacity analysis of unsteady heat conduction assumes a constant uniform temperature throughout a solid body.

Reason (R) : The surface convection resistance is very large compared with the internal conduction resistance.

105. *Assertion (A)* : In a practical vapour compression refrigerator, the vapour should leave the evaporator with a definite amount of superheat.

Reason (R) : It reduces the work done by the compressor.

106. *Assertion (A)* : When a thin flat plate is held parallel to a fluid stream, both pressure drag as well as viscous drag will be negligible.

Reason (R) : The total drag will be entirely due to shear stress and pressure drag will be negligible.

107. *Assertion (A)* : When the surface of a lake is cooled during winter, the cooled surface water descends to the bottom as long as its temperature exceeds 4°C , but when cooled below 4°C it floats at the top.

Reason (R) : Ice forms at the top of a pond in winter while bottom fluid stays warmer at more than 4°C .

108. *Assertion (A)* : The important property for a liquid to use it as manometric fluid is its colour for visibility.

Reason (R) : Inclined manometers are used to measure low pressures.

109. *Assertion (A)* : An air filled balloon released from the ground goes up and up till it reaches a certain elevation and floats in the air.

Reason (R) : With increase in elevation the temperature of the atmospheric air increases and so the density decreases.

110. *Assertion (A)* : Stability of a floating body is determined by the relative position of the centre of gravity and the centre of buoyancy.

Reason (R) : If metacentre of the floating body is above the centre of gravity of the body, then the floating body will be in stable equilibrium.

111. *Assertion (A)* : A floating body of spherical shape shall always be in neutral equilibrium condition.

Reason (R) : For a spherical floating body the centre of gravity is always above the centre of buoyancy.

112. *Assertion (A)* : In free cylindrical vortex about a vertical axis, pressure increases with distance from axis and this increase is proportional to square of the radial distance.

Reason (R) : Tangential velocity is inversely proportional to radial distance and energy of a fluid element is conserved in a free cylindrical vortex.

113. *Assertion (A)* : The velocity potential provides an alternative means of expressing velocity components.

Reason (R) : The existence of velocity potential in a flow field ensures that the flow must be irrotational.

114. *Assertion (A)* : A pitot tube works on the principle of converting kinetic energy into potential energy.

Reason (R) : The oncoming upstream velocity of fluid decelerates and comes to rest at the stagnation point at the tip of the pitot tube.

115. *Assertion (A)* : For a fully developed laminar flow through a pipe, velocity distribution across any section is parabolic in shape.

Reason (R) : The shear stress distribution from the centre line of the pipe upto the pipe surface increases linearly.

116. *Assertion (A)* : When a circular cylinder is placed normal to the direction of flow, drag force is essentially a function of the Reynolds number of the flow.

Reason (R) : As Reynolds number is about 100 and above, eddies formed break away from either side in periodic fashion, forming a meandering street called the Karman Vortex street.

117. *Assertion (A)* : The modern electric power generating plants use only water tube boilers and not fire tube boilers.

Reason (R) : The water tube boilers are comparatively cheaper in first cost than fire tube boilers.

118. *Assertion (A)* : Single stage impulse steam turbines are not used in practice.

Reason (R) : Single stage impulse steam turbines have very low revolutions per minute.

119. *Assertion (A)* : The performance parameter 'Polytropic efficiency' is used for axial flow gas turbines and air compressors.

Reason (R) : Polytropic efficiency is dependent on the pressure ratio.

120. *Assertion (A)* : Before starting a centrifugal pump it is to be properly primed.

Reason (R) : Priming provides lubrication to the propeller shaft.

SPACE FOR ROUGH WORK

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