

Sol. (a) Both A and R are true, and R provides correct explanation for A.

63. Assertion A : The Lewis equation for gear tooth with involute profile predicts the static load capacity of cantilever beam of uniform strength.

Reason R : For a pair of meshing gears with involute tooth profile, the pressure angle and module must be the same to satisfy the condition of interchangeability.

Sol. (b) Both A and R are true, but R is not right explanation for A.

64. Assertion A : Oldham coupling is used to transmit power between two parallel shafts which are slightly offset.

Reason R : There is no sliding member to reduce power in Oldham coupling.

Sol. (c) A is true and R is false.

65. Assertion A : In hydrodynamic journal bearings, the rotating journal is held in floating condition by the hydrodynamic pressure developed in the lubricant.

Reason R : Lubricant flows in a converging-diverging channel.

Sol. (a) Both A and R are true and R provides correct explanation for A.

66. Assertion A : When a link has pure translation, the resultant force must pass through the centre of gravity.

Reason R : The direction of the resultant force would be in the direction of acceleration of the body.

Sol. (d) A is false and R is true.

67. The following parameters determine the model of continuous chip formation :

1. True feed
2. Cutting velocity.
3. Chip thickness
4. Rake angle of the cutting tool.

The parameters which govern the value of shear angle would include

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

Sol. (b) Shear angle is function of 1, 3 and 4.

68. What is the correct sequence of the following parameters in order of their maximum to minimum influence on tool life?

1. Feed rate
2. Depth of cut
3. Cutting speed.

Select the correct answer using the codes given below:

Codes :

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

Sol. (d) Correct order is 3, 1, 2.

69. Tool geometry of a single point cutting tool is specified by the following elements:

1. Back rake angle
2. Side rake angle.
3. End cutting edge angle
4. Side cutting edge angle.
5. Side relief angle
6. End relief angle.
7. Nose radius.

The correct sequence of these tool elements used for correctly specifying the tool geometry is

- (a) 1, 2, 3, 6, 5, 4, 7 (b) 1, 2, 6, 5, 3, 4, 7 (c) 1, 2, 5, 6, 3, 4, 7 (d) 1, 2, 6, 3, 5, 4, 7.

Sol. (b) Correct sequence is as per (b).

70. Consider the following tool materials :

1. Carbide
2. Cernet
3. Ceramic
4. Borazon.

Correct sequence of these tool materials in increasing order of their ability to retain their hot hardness is

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

Sol. (a) Correct sequence is 1, 2, 3 and 4.

71. The ratio of thrust force to cutting force is nearly 2.5 in
 (a) turning (b) broaching (c) grinding (d) plain milling.

Sol. (c) Ratio of thrust force to cutting force is nearly 2.5 in grinding.

72. Which one of the following operations is carried out at the minimum cutting velocity if the machines are equally rigid and the tool work materials are the same?
 (a) Turning (b) Grinding (c) Boring (d) Milling

Sol. (d) Minimum cutting velocity is in milling.

73. Given that, average cutting speed = 9 m/min, the return time to cutting time ratio is = 1 : 2, the feed rate = 0.3 mm/stroke, the clearance at each end of cut = 25 mm
 and that the plate is fixed with 700 mm side along the direction of tool travel, the time required for finishing one flat surface of a plate of size 700 × 30 mm in a shaper, will be
 (a) 10 min (b) 12.5 min (c) 15 min (d) 20 min

Sol. (b) $\frac{30}{0.3} = 100$ stroke ; Cutting time = $\frac{0.75}{9} \times \frac{3}{2} \times 100 = 12.5$ min.

74. Consider the following statements regarding grinding of high carbon steel:

1. Grinding at high speed results in the reduction of chip thickness and cutting forces per grit.
2. Aluminium oxide wheels are employed.
3. The grinding wheel has to be of open structure.

Of these statements

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

Sol. (b) 1 and 2 are correct.

75. Enlarging an existing circular hole with a rotating single point tool is called
 (a) boring (b) drilling (c) reaming (d) internal turning.

Sol. (a) Enlarging an existing circular hole with a rotating single point tool is called boring.

76. Consider the following operations:

1. Cutting key ways on shafts.
2. Cutting external screw threads.
3. Cutting teeth of spur gears.
4. Cutting external splines.

Those which can be performed with milling cutters would include

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

Sol. (c) Milling cutters can do operations 1 and 3.

77. Consider the following machine tools:

1. Hobbing machine.
2. Gear shaping machine.
3. Broaching machine.

The teeth of internal spur gears can be cut in

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

Sol. (d) Teeth of internal spur gears can be cut in gear shaping and broaching machines.

78. Match List I with List II and select the correct answer using the codes given below the Lists :

List I (Metal forming process)

List II (A similar process)

- A. Blanking
- B. Coining
- C. Extrusion
- D. Cup drawing

1. Wire drawing
2. Piercing
3. Embossing
4. Rolling
5. Bending

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

Sol. (b) Correct matching is A-2, B-3, C-1, D-4.

79. Which of the following materials can be used for making patterns ?

1. Aluminium 2. Wax 3. Mercury 4. Lead.

Select the correct answer using the codes given below:

Codes:

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

Sol. (d) Aluminium, wax and mercury can be used for making patterns.

80. Which one of the following welding processes uses non-consumable electrodes?

- (a) TIG welding (b) MIG welding
(c) Manual arc welding (d) Submerged arc welding.

Sol. (a) TIG welding uses non-consumable electrodes.

81. Match List I with List II and select the correct answer using the codes given below the Lists :

List I (Filler)

List II (Joining process)

- A. Cu, Zn, Ag alloy
B. Cu, Sn, alloy
C. Pb, Sb, alloy
D. Iron oxide and aluminium powder

1. Braze welding.
2. Brazing.
3. Soldering
4. TIG welding of aluminium.

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

Sol. (c) Correct matching is A-2, B-1, C-3, D-4.

82. In sheet metal blanking, shear is provided on punches and dies so that

- (a) press load is reduced. (b) good cut edge is obtained.
(c) warping of sheet is minimised. (d) cut blanks are straight.

Sol. (a) Shear is provided on punch and dies to reduce press load.

83. For obtaining a cup of diameter 25 mm and height 15 mm by drawing, the size of the round blank should be approximately

- (a) 42 mm (b) 44 mm (c) 46 mm (d) 48 mm

Sol. (c) $D = \sqrt{d^2 + 4dh} = \sqrt{25^2 + 4 \times 25 \times 15} = 46 \text{ mm}$.

84. Which of the following pairs of process and draft are correctly matched ?

1. Rolling 2. 2. Extrusion 50.
3. Forging 4.

Select the correct answer using the codes given below:

Codes:

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

Sol. (a) 1, 2 and 3 are correctly matched.

85. The mode of deformation of the metal during spinning is

- (a) bending (b) stretching
(c) rolling and stretching (d) bending and stretching.

Sol. (d) Mode of deformation of metal during spinning is bending and stretching.

86. In drop forging, forging is done by dropping

- (a) the work piece at high velocity
- (b) the hammer at high velocity.
- (c) the die with hammer at high velocity.
- (d) a weight on hammer to produce the requisite impact.

Sol. (c) In drop forging, forging is done by dropping the die with hammer at high velocity.

87. Metal extrusion process is generally used for producing

- (a) uniform solid sections
- (b) uniform hollow sections
- (c) uniform solid and hollow sections
- (d) varying solid and hollow sections.

Sol. (d) Metal extrusion process is generally used for producing varying solid and hollow sections.

88. In reaming process

- (a) metal removal rate is high
- (b) high surface finish is obtained.
- (c) high form accuracy is obtained
- (d) high dimensional accuracy is obtained.

Sol. (d) In reaming process, high dimensional accuracy is obtained.

89. The ratio between two consecutive spindle speeds for a six-speed drilling machine using drills of diameter 6.25 to 25 mm size and at a cutting velocity of 18 m/min is

- (a) 1.02
- (b) 1.32
- (c) 1.62
- (d) 1.82

Sol. (c) $\phi^5 = 4$, $\phi = \sqrt[5]{4} = 1.62$

90. In a single spindle automatic lathe two tools are mounted on the turret, one form tool on the front slide and the other, a parting tool on the rear slide. The parting tool operation is much longer than form tool operation and they operate simultaneously (overlap). The number of cams required for this job is

- (a) one
- (b) two
- (c) three
- (d) four

Sol. (a) One cam is required.

91. Feed drives in CNC milling machines are provided by

- (a) synchronous motors
- (b) induction motors
- (c) stepper motors
- (d) servo-motors.

Sol. (d) Feed drive in CNC is by servo motor.

92. In a transfer line

- (a) all the machine tools must be automatic.
- (b) the work stations must form a closed-loop.
- (c) the cycle time is total time taken by all the machining operations.
- (d) all the machine tools must be of conventional and general purpose type.

Sol. (a) In transfer line, all the machine tools must be automatic.

93. Consider the following statements regarding fixtures employed for holding work piece during machining:

1. The location is based on the 3-2-1 principle.
2. The numbers refer to the pins employed in three mutually perpendicular planes to arrest all the degrees of freedom.
3. Fixture also provides tool guidance.

Of these statements

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

Sol. (a) Statements 1,2 and 3 are correct.

94. Which of the following pairs are correctly matched?

1. Resilience.... Resistance to deformation.
2. Malleability..... Shape change.
3. Creep Progressive deformation.
4. Plasticity....Permanent deformation.

Select the correct answer using the codes given below :

Codes:

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

Sol. (d) Pairs at 1,3 and 4 are correctly matched.

95. Consider the following treatments:

1. Normalising 2. Hardening. 3. Martempering 4. Cold working.

Hardness and tensile strength in austenitic stainless steel can be increased by

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

Sol. (d) Hardness and tensile strength in austenitic steel can be increased by cold working alone.

96. Killed steels

- (a) have minimum impurity level.
 (b) have almost zero percentage of phosphorus and sulphur
 (c) are produced by LD process. (d) are free from oxygen.

Sol. (d) Killed steels are free from oxygen.

97. Which of the following pairs are correctly matched ?

1. Silicon steels Transformer stampings. 2. Duralumin..... Cooking utensils.
 3. Gun metal.... Bearings.

Select the correct answer using the codes given below.

Codes:

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

Sol. (a) Correct matching is for 1, 2 and 3.

98. Which of the following pairs of plastics and their modes of formation are correctly matched ?

1. Polythene.....Condensation polymerisation.
 2. PolycarbonateAddition polymerisation.
 3. Polystyrene....Addition polymerisation.
 4. Polyamide.....Either by addition or by condensation polymerisation.

Select the correct answer using the codes given below:

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

Sol. (d) Correct matching is for 3 and 4.

99. Cubic boron nitride is used

- (a) as lining material in induction furnaces (b) for making optical quality glass.
 (c) for heat treatment (d) for none of the above.

Sol. (d) None of the uses is true for CBN.

100. Match List I (materials) with List II (applications) and select the correct answer using the codes given below the Lists:

List I

- A. Engineering ceramics
 B. Fibre reinforced plastics
 C. Synthetic carbon
 D. Boron

Codes: A B C D

(a) 1 2 3 4

(c) 2 3 1 4

List II

1. Bearings.
 2. Control rods in nuclear reactors.
 3. Aerospace industry
 4. Electrical insulator

 A B C D

(b) 1 4 3 2

(d) 4 3 1 2

Sol. (d) Correct matching is A-4, B-3, C-1, D-2.

101. Consider the following objectives:

1. To train the individual regarding motion economy.
2. To assist in research projects in the field of work study.
3. To help in the collection of Motion Time data.

The objectives of Micromotion Study would include

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

Sol. (d) Objectives 1 and 3 are true for micromotion study.

102. Which of the following pairs are correctly matched?

1. Lead screw nut.....Phosphor bronze.
2. Piston.....Cast iron.
3. Cam.....EN-31 steel.
4. Lead screw.....Wrought iron.

Select the correct answer using the codes given below:

Codes:

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

Sol. (d) Pairs at 1,2 and 3 are correctly matched.

103. Consider the following steps:

1. Method time measurement
2. Work sampling
3. Work factor system.

PMTS (Predetermined motion time systems) in work study would include

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

Sol. (d) PMTS includes 1 and 3.

104. Earning in Rowan system = $R \times T_s + \frac{T_s - T_a}{T_s} T_a R$, Earning in 50% Halsey plan = $R \times T_s + p(T_s - T_a) R$,

where R = hourly rate, T_a = actual completion time of task

T_s = standard time for the task, p = percentage allowed.

Both Rowan system and 50% Halsey plan will provide the same earning when the actual time is

- (a) equal to standard time (b) half the standard time
(c) one-quarter of standard time (d) twice the standard time.

Sol. (b) (b) is correct answer.

105. Which one of the following steps would lead to interchangeability ?

- (a) Quality control (b) Process planning (c) Operator training (d) Product design.

Sol. (a) Quality control leads to interchangeability.

106. Match List I with List II and select the correct answer using the codes given below the Lists :

List I (Element of cost)

List II (Nature of cost)

A. Interest on capital

1. Variable

B. Direct labour

2. Semi-variable

C. Water and electricity

3. Fixed.

Codes : A B C

 A B C

(a) 3 1 2

(b) 2 1 3

(c) 3 2 1

(d) 2 3 1

Sol. (c) Correct matching is A-3, B-2, C-1.

107. Consider the following situations that would warrant a study of the layout :

1. Change in the work force.
2. Change in production volume.
3. Change in product design.
4. Competition in the market.

The situation (s) that would lead to a change in the layout would include

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

Sol. (c) Study of layout is called for in case of change in product design.

108. Match List I with List II and select the correct answer using the codes given below the Lists :

List I (Products)

List II (Factors for site selection)

- A. Aluminium
B. Photographic material
C. Cement
D. Jigs and fixtures

1. Transportation cost.
2. Skilled labour.
3. Abundance of power.
4. Climatic conditions.

Codes : A B C D

 A B C D

(a) 3 2 1 4

(b) 3 2 4 1

(c) 3 4 1 2

(d) 1 4 3 2

Sol. (c) Correct matching is A-3, B-4, C-1, D-2.

109. There are two products A and B with the following characteristics :

Product	Demand (in units)	Order cost (in Rs./order)	Holding cost (in Rs./unit/years)
A.	100	100	4
B.	400	100	1

The economic order quantities (EOQ) of product A and B will be in the ratio of

- (a) 1 : 1 (b) 1 : 2 (c) 1 : 4 (d) 1 : 8

Sol. (a) EOQ of A and B is in ratio of 1 : 1 being $\sqrt{\frac{2AD}{h}} = \sqrt{\frac{2 \times \text{Order cost} \times \text{Demand}}{\text{Holding cost}}}$

110. A device used for lifting or lowering objects suspended from a hook at the end of retractable chains or cable is called

- (a) hoist (b) jib crane (c) portable elevator (d) chain conveyor

Sol. (a) Hoist.

111. Match List I with List II and select the correct answer using the codes given below the Lists :

List I

List II

- A. Linear programming problem
B. Queueing problem
C. Dynamic problem
D. Game theory problem

1. Travelling salesman
2. Saddle point
3. Product mix
4. Normal distribution

Codes: A B C D

 A B C D

(a) 3 4 1 2

(b) 4 3 1 2

(c) 3 4 2 1

(d) 4 3 2 1

Sol. (a) Correct matching is A-3, B-4, C-1, D-2.

112. A simplex table for a linear programming problem is given below :

	5 X1	2 X2	3 X3	0 X4	0 X5	0 X6	Z
X4	1	2	2	1	0	0	8
X5	3	4	1	0	1	0	7
X6	2	3	4	0	0	1	10

Which one of the following correctly indicates the combination of entering and leaving variables ?

- (a) X1 and X4 (b) X2 and X6 (c) X2 and X5 (d) X3 and X4

Sol. (c) The combination of entering and leaving variables corresponds to Z being minimum and maximum value of row in table.

113. A feasible solution to the linear programming problem should

- (a) satisfy the problem constraints.
 (b) optimise the objective function.
 (c) satisfy the problem constraints and non-negativity restrictions.
 (d) satisfy the non-negativity restrictions.

Sol. (a) A feasible solution to the linear programming problem should satisfy the problem constraints.

114. If the arrival takes place every 10 minutes with a service times of 4 minutes per unit, then the mean arrival rate, mean service rate and the probability that one would have to wait will be respectively.

- (a) 10, 4 and 0.25 (b) 0.1, 0.25 and 0.4 (c) 10, 0.4 and 0.25 (d) 0.1, 0.25 and 0.1

Sol. (b) $\lambda = \frac{1}{10} = 0.1$, $\mu = \frac{1}{4} = 0.25$ and $P = \frac{\lambda}{\mu} = \frac{0.1}{0.25} = 0.4$

115. In a M/M/1 queueing system, the expected waiting time of a unit that actually waits is given by

- (a) $\frac{\lambda}{\mu(\mu - \lambda)}$ (b) $\frac{\lambda}{\mu - \lambda}$ (c) $\frac{1}{\mu - \lambda}$ (d) $\frac{\lambda}{\mu^2(\mu - \lambda)}$

Sol. (a) Expected waiting time = $\frac{\lambda}{\mu(\mu - \lambda)}$

116. Consider the following phases:

1. Information phase 2. Evaluation phase 3. Creative phase 4. Investigation phase.

The correct sequence of these phases in value engineering is

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

Sol. (b) Correct sequence is 1, 3, 2, 4.

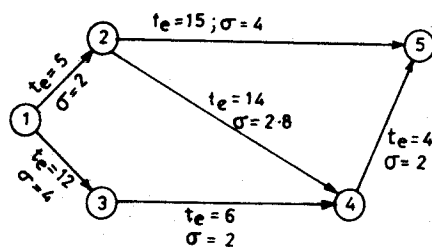
117. In a connected network of 'n' arcs (roads) joining 'm' vertices (towns), a selection of roads is taken up for resurfacing based on a minimum spanning tree of network as being the least cost solution. This spanning tree will contain

- (a) m arcs (b) (m + 1) arcs (c) (m - 1) arcs (d) (m + n - 1) arcs

Sol. (a) Spanning tree will have m + n - 1 acrs.

118. For the PERT network shown in the given figure, the probability of completing the project in 27 days is

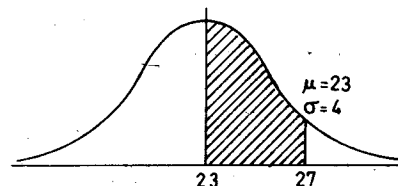
- (a) 0.841 (b) 0.919 (c) 0.964 (d) 0.977



Sol. (a) Critical path is 1-2-4-5

$t_e = \text{expected project time} = 5 + 14 + 4 = 23 \text{ days}$

$\sigma = \sqrt{2^2 + 2.8^2 + 2^2} \cong 4$



$$Z = \frac{27 - 23}{4} = 1$$

Area for $Z = 1$ is 0.341

\therefore Probability $0.5 + 0.341 = 0.841$

119. In CPM, the cost slope is determined by

- (a) $\frac{\text{Crash cost}}{\text{Normal cost}}$ (b) $\frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$
 (c) $\frac{\text{Normal cost}}{\text{Crash cost}}$ (d) $\frac{\text{Normal cost} - \text{Crash cost}}{\text{Normal time} - \text{Crash time}}$

Sol. (b) Cost slope = Crash Cost = $\frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$

120. Match List I with List II and select the correct answer using the codes given below the Lists :

List I

- A. Memory
 B. Software for layout
 C. Compiler
 D. Simulation

List II

1. Assembler
 2. Buffer
 3. GPSS
 4. Hardware
 5. CRAFT

Codes: A B C D

(a) 2 3 1 4

(c) 4 5 1 3

A B C D

(b) 3 2 4 5

(d) 2 5 4 3

Sol. (d) Correct matching is A-2, B-5, C-4, D-3.

Engineering Services Examination
MECHANICAL ENGINEERING—1995
PAPER-I

1. 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.
2. You have to mark all your responses ONLY on the separate Answer Sheet provided. See directions in the Answer Sheet.
3. All items carry equal marks. Attempt all items. Your total marks will depend only on the number of correct responses marked by you in the Answer Sheet.

1. The depth of a fluid is measured in vertical z -direction; x and y are the other two directions and are mutually perpendicular. The static pressure variation in the fluid is given by (symbols have the usual meaning).

- (a) $dp/dz = g$ (b) $dp/dz = \rho g$ (c) $dp/dz = \rho g$ (d) $dp/dz = (-) \rho g$.

Sol. (d) The static pressure variation in the fluid is given by $\frac{dp}{dz} = -\rho g$

2. In a two-dimensional flow, the velocity components in x and y directions in terms of stream function (ψ) are

- (a) $u = \partial\psi/\partial x, v = \partial\psi/\partial y$ (b) $u = \partial\psi/\partial y, v = \partial\psi/\partial x$
(c) $u = (-) \partial\psi/\partial y, v = \partial\psi/\partial x$ (d) $u = \partial\psi/\partial x, v = -\partial\psi/\partial y$

Sol. (b) In two dimensional flow, the velocity components in x and y direction in term of stream function

ψ are $u = \frac{\partial\psi}{\partial y}, \frac{\partial\psi}{\partial x}$

3. If H is the total head at inlet and h_1 is the head lost due to friction, efficiency of power transmission through a straight pipe is given by

- (a) $(H - h_1)/H$ (b) $H/(H + h_1)$
(c) $(H - h_1)/(H+h_1)$ (d) $H/(H - h_1)$

Sol. (a) η of power transmission though a pipe = $\frac{H - h_1}{H}$.

4. A dimensionless group formed with the variables ρ (density), ω (angular velocity), μ (dynamic viscosity) and D (characteristic diameter) is

- (a) $\rho\omega\mu/D^2$ (b) $\rho\omega D^2/\mu$ (c) $\rho\omega\mu D^2$ (d) $\rho\omega\mu D$

Sol. (b) Dimensionless group formed with ρ, ω, μ and D is $\rho\omega D^2/\mu$

5. Flow over a half body is studied by utilising a free stream velocity of 5 m/s superimposed on a source at the origin. The body has a maximum width of 2m. The co-ordinates of the stagnation point are

- (a) $x = 0.32 \text{ m}, y = 0$ (b) $x = 0, y = 0$
(c) $x = (-) 0.32 \text{ m}, y = 0$ (d) $x = 3 \text{ m}, y = 2 \text{ m}$

Sol. (b) Stagnation point is a point on the surface of a body past which the fluid is moving. The coordinates of stagnation point are $x = 0, y = 0$.

6. The following terms relate to floating bodies:

Centre of gravity ... G , Meta Centre ... M
Weight of floating body ... W , Buoyant force ... F_B

Match List I with List II and select the correct answer.

List I (Condition)

- A. G is above M
B. G and M coincide
C. G is below M
D. $F_B \geq W$

List II (Result)

1. Stable equilibrium
2. Unstable equilibrium
3. Floating body
4. Neutral equilibrium

Codes : A B C D

(a) 1 3 2 4

(c) 2 3 4 1

A B C D

(b) 3 1 4 2

(d) 2 4 1 3

Sol. (d) The correct matching is A-2, B-4, C-1, D-3.

7. For fully developed laminar flow through a pipe the volumetric flow is given by (symbols have the usual meaning)

(a) $\frac{\pi}{8\mu} R^4 \left(-\frac{dp}{dz} \right)$

(b) $\frac{\pi}{4\mu} R^4 \left(-\frac{dp}{dz} \right)$

(c) $\frac{\pi}{32\mu} R^4 \left(-\frac{dp}{dz} \right)$

(d) $\frac{\pi}{16\mu} R^4 \left(-\frac{dp}{dz} \right)$

Sol. (a) For fully developed laminar flow through a pipe, volumetric flow = $\frac{\pi}{8\mu} R^4 \left(-\frac{dp}{dz} \right)$.

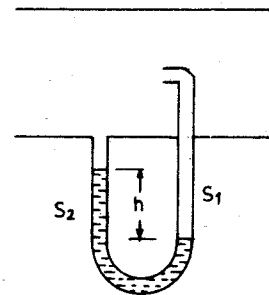
8. A Prandtl Pitot tube was used to measure the velocity of a fluid of specific gravity S_1 . The differential manometer, with a fluid of specific gravity S_2 , connected to the Pitot tube recorded a level difference as h . The velocity V is given by the expression.

(a) $\sqrt{2gh (S_1/S_2 - 1)}$

(b) $\sqrt{2gh (S_2/S_1 - 1)}$

(c) $\sqrt{2gh (S_1 - S_2)}$

(d) $\sqrt{2gh (S_2 - S_1)}$



Sol. (d) Velocity head is $\frac{V^2}{2g} = hS_2 - hS_1$, and $V = \sqrt{2gh (S_2 - S_1)}$

9. The expression $(p + \rho gz + \rho v^2/2)$ commonly used to express Bernoulli's equation, has units of

(a) total energy per unit mass

(b) total energy per unit weight.

(c) total energy per unit volume

(d) total energy per unit cross-sectional area of flow.

Sol. (c) The expression $p + \rho gz + \frac{\rho V^2}{2}$ has units of $\frac{N}{m^2}$ or $\frac{Nm}{m^3} \left(\frac{\text{energy}}{\text{volume}} \right)$

10. The frictional head loss in a turbulent flow through a pipe varies

(a) directly as the average velocity.

(b) directly as the square of the average velocity.

(c) inversely as the square of the average velocity.

(d) inversely as the square of the internal diameter of the pipe.

Sol. (b) Frictional head loss in turbulent flow varies directly as the square of average velocity.

11. Match List I with List II and select the correct answer.

List I (Properties of fluids)

- A. Ideal fluid
- B. Newtonian fluid
- C. μ/ρ
- D. Mercury in glass

Codes :	A	B	C	D
(a)	1	2	4	6
(c)	2	1	3	6

List II (Definition / Results)

- 1. Viscosity does not change with rate of deformation.
- 2. Fluid of zero viscosity
- 3. Dynamic viscosity.
- 4. Capillary depression.
- 5. Kinematic viscosity.
- 6. Capillary rise.

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

Sol. (c) The correct matching is A-2, B-1, C-3, D-6.

12. List I give the different items related to a boundary layer while List II gives the mathematical expressions. Match List I with List II and select the correct answer using the codes given below the lists : (symbols have the usual meaning).

List I

- A. Boundary layer thickness
- B. Displacement thickness
- C. Momentum thickness
- D. Energy thickness

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

List II

- 1. $y = \delta, u = 0.99U_\infty$
- 2. $\int_0^\delta \left(1 - \frac{u}{U_\infty}\right) dy$
- 3. $\int_0^\delta \frac{u}{U_\infty} \left(1 - \frac{u}{U_\infty}\right) dy$
- 4. $\int_0^\delta \frac{u}{U_\infty} \left(1 - \frac{u^2}{U_\infty^2}\right) dy$

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

Sol. (a) The correct matching is A-1, B-2, C-3, D-4.

13. The differential form of continuity equation for two-dimensional flow of fluid may be written in the following form $\rho \frac{\partial u}{\partial x} + \rho \frac{\partial v}{\partial y} = 0$

in which u and v are velocities in the x and y -direction and ρ is the density. This is valid for

- (a) compressible, steady flow
- (b) compressible, unsteady flow
- (c) incompressible, unsteady flow
- (d) incompressible, steady flow.

Sol. (d) The equation $\rho \frac{\partial u}{\partial x} + \rho \frac{\partial v}{\partial y} = 0$ is valid for incompressible steady flow.

14. Water hammer in pipe lines takes place when

- (a) fluid is flowing with high velocity
- (b) fluid is flowing with high pressure
- (c) flowing fluid is suddenly brought to rest by closing a valve.
- (d) flowing fluid is brought to rest by gradually closing a valve.

Sol. (c) Water hammer in pipe lines takes place when flowing fluid is suddenly brought to rest by closing a valve.

15. A laminar boundary layer occurs over a flat plate at zero incidence to the flow. The thickness of boundary layer at a section 2 m from the leading edge is 2 mm. The thickness of boundary layer at a section 4 m from the leading edge will be

(a) $2 \times (2)^2$ mm (b) $2 \times (2)^{1/2}$ mm (c) $2 \times (2)^{4/5}$ mm (d) $2 \times (2)^{1/5}$ mm

Sol. (b) Thickness of boundary layer at 4 mm from leading edge = $2 \times (4/2)^{1/2} = 2 \times 2^{1/2}$ mm

16. The model of a propeller, 3 m in diameter, cruising at 10 m/s in air, is tested in a wind tunnel on a 1 : 10 scale model. If a thrust of 50 N is measured on the model at 5 m/s wind speed, then the thrust on the prototype will be

(a) 20,000 N (b) 2,000 N (c) 500 N (d) 200 N.

Sol. (a) Force ratio = $\frac{\rho_m}{\rho_p} \times \frac{L_m^2}{L_p^2} \times \frac{V_m^2}{V_p^2}$; $\frac{F_m}{F_p} = 1 \times \left(\frac{1}{10}\right)^2 \times \left(\frac{5}{10}\right)^2$
 or $\frac{50}{F_p} = \frac{1}{100} \times \frac{1}{4}$ or $F_p = 50 \times 400 = 20000$ N

17. A hydraulic power station has the following major items in the hydraulic circuit:

1. Draft tube 2. Runner 3. Guide wheel 4. Penstock
 5. Scrol case.

The correct sequence of these items in the direction of flow is

(a) 4, 2, 3, 1, 5 (b) 4, 3, 2, 5, 1 (c) 1, 2, 3, 5, 4 (d) 1, 3, 2, 4, 5.

Sol. (b) The sequence of various items in hydraulic plant is penstock, guide wheel, runner, scrol case, draft tube.

18. For solid spheres falling vertically downwards under gravity in a viscous fluid, the terminal velocity, V_1 varies with diameter ' D ' of the sphere as

(a) $V_1 \propto D^{1/2}$ for all diameters (b) $V_1 \propto D^2$ for all diameters

(c) $V_1 \propto D^{1/2}$ for large D and $V_1 \propto D^2$ for small D

(d) $V_1 \propto D^2$ for large D and $V_1 \propto D^{1/2}$ for small D .

Sol. (b) Terminal velocity $V_1 \propto D^2$ for all diameters.

19. In the region of the boundary layer nearest to the wall where velocity is not equal to zero, the viscous forces are.

(a) of the same order of magnitude as the inertial forces.

(b) more than inertial forces.

(c) less than inertial forces

(d) negligible.

Sol. (c) Statement at (c) is correct.

20. The degree of reaction of a turbine is defined as the ratio of

(a) static pressure drop to total energy transfer

(b) total energy transfer to static pressure drop.

(c) change of velocity energy across the turbine to the total energy transfer.

(d) velocity energy to pressure energy.

Sol. (a) Degree of reaction of turbine is ratio of static pressure drop to total energy transfer.

21. The movable wicket gates of a reaction turbine are used to

(a) control the flow of water passing through the turbine.

(b) control the pressure under which the turbine is working.

(c) strengthen the casing of the turbine.

(d) reduce the size of the turbine.

Sol. (a) The movable wicket gates of a reaction turbine are used to control the flow of water passing through the turbine.

28. Assertion (a) : If an alcohol and a mercury thermometer read exactly 0°C at the ice point and 100°C at the steam point and the distance between the two points is divided into 100 equal parts in both thermometers, the two thermometers will give exactly the same reading at 50°C .

Reason (R) : Temperature scales are arbitrary.

Sol. (a) Both A and R are correct and R is true explanation for A.

29. Assertion (A) : The thermal efficiency of gas turbine plants is higher compared to diesel plants.

Reason (R) : The mechanical efficiency of gas turbines is higher compared to diesel engines.

Sol. (d) A is false and R is true.

30. Assertion (A) : A simple carburettor which is set to give a correct mixture at low air speeds will give a progressively rich mixture as the air speed is increased.

Reason (R) : As the pressure difference over the jet of a simple carburettor increases the weight of petrol discharge increases at a greater rate than does the air supply.

Sol. (a) Both A and R are true and R provides correct explanation for A.

31. Assertion (A) : In the subsonic range the propulsive efficiency of a rocket is less than that of a turbojet.

Reason (R) : The jet velocity of rocket is independent of forward motion.

Sol. (b) Both A and R are true but R is not correct explanation of A.

32. Assertion (A) : All boilers used in power plants necessarily use forced circulation.

Reason (R) : Forced circulation increases heat transfer.

Sol. (d) Boilers of 200-250 MW used in power plants are based on natural circulation. Forced circulation increases heat transfer.

33. Assertion (A) : The work required per kg of air flow / min. for axial flow compressors is lower than that for centrifugal compressor for the same pressure ratio.

Reason (R) : The isentropic efficiency of axial flow compressor is much higher than that of a centrifugal compressor.

Sol. (a) Both A and R are correct and R provides right explanation for A.

34. Assertion (A) : Gas turbines use very high air fuel ratio.

Reason (R) : The allowable maximum temperature at the turbine inlet is limited by available material considerations.

Sol. (b) Though A and R are true, but R is not correct reason for A.

35. Assertion (A) : Addition of insulation to the inside surface of a pipe always reduces heat transfer rate and critical radius concept has no significance.

Reason (R) : If insulation is added to the inside surface, both surface resistance and internal resistance increase.

Sol. (a) A and R are correct. R is right reason for A.

36. Assertion (A) : When heat is transferred from a cylinder in cross flow to an air stream, the local heat transfer coefficient at the forward stagnation point is large.

Reason (R) : Due to separation of the boundary layer eddies continuously sweep the surface close to the forward stagnation point.

Sol. (a) A and R are correct. R is right explanation for A.

37. Assertion (A) : Even though dropwise condensation is more efficient, surface condensers are designed on the assumption of filmwise condensation as a matter of practice.

Reason (R) : Dropwise condensation can be maintained with the use of promoters like oleic acid.

Sol. (b) A and R are true. R is not correct reason for A.

38. Assertion (a) : Heat pump used for heating is a definite advancement over the simple electric heater.

Reason (R) : The heat pump is far more economical in operation than electric heater.

Sol. (a) A and R are right. R is also correct reason for A.

39. Assertion (A) : In vapour compression refrigeration system throttle valve is used and not expansion cylinder.

Reason (R) : Throttling is a constant enthalpy process.

Sol. (b) A and R are true. But R is not right reasoning for A.

40. Assertion (A) : Never connect a solenoid valve directly to the motor leads.

Reason (R) : The high current drawn to start the motor may drop the voltage enough to prevent the valve from opening.

Sol. (a) A and R are correct. R is also right reason for A.

41. Assertion (A) : There will be a redistribution of pressure and velocity from inside of the bend to the outside while a fluid flows through a pipe bend.

Reason (R) : The spacing between stream lines will increase towards the outside wall and decrease towards the inside wall of the bend and thereby create a positive pressure gradient between outside wall to inside wall of the bend.

Sol. (a) A and R are correct. R is also right reason for A.

42. Assertion (A) : Nature of the fluid flow in a pipe does not depend entirely on average velocity but is actually a function of the Reynold's number.

Reason (R) : Reynold's number depends not only on average velocity but also on the diameter of the pipe and kinematic viscosity of the fluid.

Sol. (b) Both A and R are correct but R does not provide right reason for A.

43. Assertion (A) : With increase in discharge in a single stage centrifugal pump the BHP goes on increasing but beyond a certain discharge the BHP starts decreasing.

Reason (R) : Efficiency of the pump starts decreasing beyond a certain discharge.

Sol. (d) A is false and R is true.

44. Joule-Thomson coefficient is defined as

$$(a) \left(\frac{\partial T}{\partial p} \right)_h \quad (b) \left(\frac{\partial h}{\partial p} \right)_T \quad (c) \left(\frac{\partial h}{\partial T} \right)_p \quad (d) \left(\frac{\partial p}{\partial T} \right)_h$$

Sol. (a) Joule-Thomson coefficient is $\left[\frac{\partial T}{\partial p} \right]_h$

45. The internal energy of a certain system is a function of temperature alone and is given by the formula $E = 25 + 0.25t$ kJ. If this system executes a process for which the work done by it per degree temperature increase is 0.75 kN-m, the heat interaction per degree temperature increase, in kJ, is

$$(a) -1.00 \quad (b) -0.50 \quad (c) 0.50 \quad (d) 1.00$$

Sol. (d) $dQ = du + dw = 0.25 + 0.75 = 1.00$ kJ

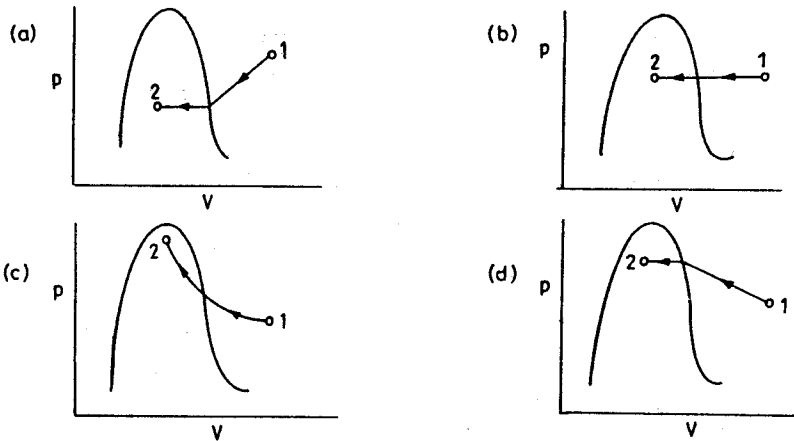
46. The correct sequence of the decreasing order of the value of characteristic gas constants of the given gases is

$$(a) \text{ hydrogen, nitrogen, air, carbon dioxide} \quad (b) \text{ carbon dioxide, hydrogen, nitrogen, air.}$$

$$(c) \text{ air, nitrogen, carbon dioxide, hydrogen} \quad (d) \text{ nitrogen, air, hydrogen, carbon dioxide.}$$

Sol. (a) The correct sequence for decreasing order of the value of characteristic gas constants is hydrogen, nitrogen, air and carbon dioxide.

47. Which one of the following p-V diagrams for steam illustrates the isothermal process undergone by superheated steam till it becomes wet ?



Sol. (d) Figure (d) illustrates the isotherm process undergone by steam till it becomes wet.

48. List I gives some processes of steam whereas List II gives the effects due to the processes. Match List I with List II, and select the correct answer using the codes given below the lists :

List I

List II

- | | |
|--|---------------------------------------|
| A. As saturation pressure increases | 1. Entropy increases. |
| B. As saturation temperature increases | 2. Specific volume increases. |
| C. As saturation pressure decreases | 3. Enthalpy of evaporation decreases. |
| D. As dryness fraction increases | 4. Saturation temperature increases. |

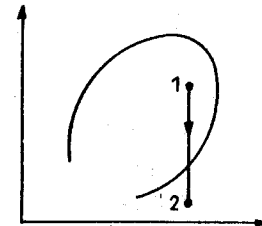
Codes :	A	B	C	D	A	B	C	D
(a)	1	3	2	4	4	3	2	1
(c)	4	3	1	2	2	4	3	1

Sol. (c) The right matching is A-4, B-3, C-1, D-2.

49. The given diagram shows the throttling process of a pure substance.

The ordinate and abscissa are respectively

- | | |
|-----------------------------|----------------------------|
| (a) pressure and volume | (b) enthalpy and entropy |
| (c) temperature and entropy | (d) pressure and enthalpy. |



Sol. (d) The throttling process given in figure is on pressure-enthalpy diagram.

50. Consider the following statements with reference to Gas turbine cycle:

1. Regeneration increases thermal efficiency.
2. Reheating decreases thermal efficiency.
3. Cycle efficiency increases when maximum temperature of the cycle is increased.

Of these statements

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

Sol. (a) All statements are correct.

51. A cycle of pressure-volume diagram is shown in the given figure 1:

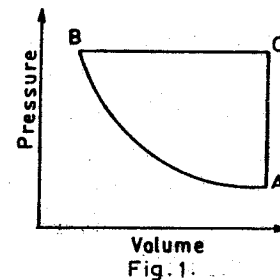
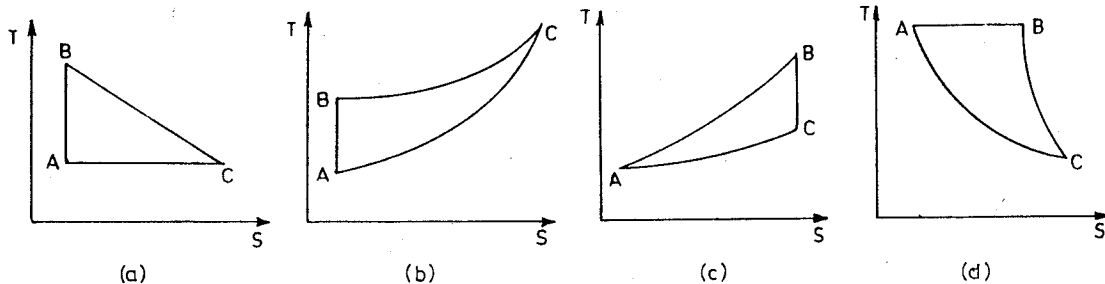


Fig. 1.

Same cycle on temperature-entropy diagram will be represented by



Sol. (d) Figure at (d) matches with given process on P-V plane.

52. The mass of air required for complete combustion of unit mass of fuel can always be calculated from the formula, where C , H , O and S are in percentage.

- (a) $0.1152C + 0.3456H$ (b) $0.1152C + 0.3456(H - 0.125O)$
 (c) $0.1152C + 0.3456(H - 0.125O) + 0.0432S$
 (d) $0.1152C + 0.3456(H + 0.125O) + 0.0432S$.

Sol. (c) Mass of air for complete combustion is $0.1152C + 0.3456(H - 0.125O) + 0.0432S$.

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

List I (Operating mode of SI engine)

List II (Appropriate Air-Fuel ratio)

- A. Idling
 B. Cold starting
 C. Cruising
 D. Maximum power

1. 12.5
 2. 9.0
 3. 16.0
 4. 22.0
 5. 3.0

Codes : A B C D

(a) 2 4 5 1

(c) 5 2 1 3

A B C D

(b) 1 3 4 2

(d) 2 5 3 1

Sol. (d) Correct matching is A-2, B-5, C-3 D-1.

54. A gas engine has a swept volume of 300 cc and clearance volume of 25 cc. Its volumetric efficiency is 0.88 and mechanical efficiency is 0.90. What is the volume of the mixture taken in per stroke ?

- (a) 248 cc (b) 252 cc (c) 264 cc (d) 286 cc

Sol. (c) Volumetric $\eta = \frac{\text{Volume of mixture}}{300}$, and vol. of mixture = $300 \times 0.88 = 264$ cc

55. Knocking in the SI engine decreases in which one of the following orders of combustion chamber designs?

- (a) F head, L head, I head (b) T head, L head, F head.
 (c) I head, T head, F head (d) F head, I head, T head.

Sol. (a) (a) is correct order for knocking in SI engines.

56. The two reference fuels used for cetane rating are

- (a) cetane and isoocatane (b) cetane and tetraethyl lead
 (c) cetane and n -heptane (d) cetane and α -methyl naphthalene.

Sol. (d) Two reference fuels for cetane rating are cetane and α -methyl naphthalene.

57. Match List I with List II, in respect of SI engines, and select the correct answer by using the codes given below the lists :

<i>List I</i>				<i>List II</i>					
A.	Highest useful compression ratio	1.	Ignitable mixture						
B.	Dopes	2.	Knock rating of fuels						
C.	Limiting mixture strength	3.	Detonation						
D.	Delay period	4.	Chain of chemical reactions in combustion chamber.						
Codes :	A	B	C	D	A	B	C	D	
(a)	2	3	1	4	(b)	3	2	1	4
(c)	2	3	4	1	(d)	3	4	2	1

Sol. (b) Correct matching is A-3, B-2, C-1, D-4.

58. By higher octane number of SI fuel, it is meant that the fuel has
 (a) higher heating value (b) higher flash point (c) lower volatility (d) longer ignition delay.

Sol. (d) A fuel with higher octane number has longer ignition delay.

59. Which of the following factors would increase the probability of knock in the CI engines ?

1. Long ignition delay of fuel
2. Low self ignition temperature of fuel
3. Low volatility of fuel

Select the correct answer using the codes given below :

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

Sol. (b) Long ignition delay and low self ignition temperature would increase the probability of knock in C.I. engines.

60. The curve show in the given figure is characteristic of diesel engines.

What does the Y-axis represent ?

- (a) Efficiency (b) Specific fuel consumption
 (c) Air-fuel ratio (d) Total fuel consumption.

Sol. (d) Y-axis represents total fuel consumption.

61. The correct sequence of the decreasing order of brake thermal efficiency of the three given basic type of IC engines is

- (a) 4 stroke CI engine, 4 stroke SI engine, 2 stroke SI engine
 (b) 4 stroke SI engine, 4 stroke CI engine, 2 stroke SI engine
 (c) 4 stroke CI engine, 2 stroke SI engine, 4 stroke SI engine
 (d) 2 stroke SI engine, 4 stroke SI engine, 4 stroke CI engine.

Sol. (a) Correct order is as per (a).

62. Keeping other parameters constant brake power diesel engine can be increased by

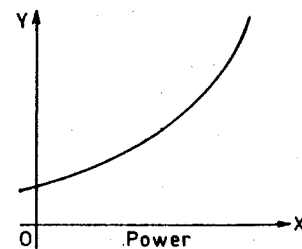
- (a) decreasing the density of intake air
 (b) increasing the temperature of intake air
 (c) increasing the pressure of intake air
 (d) decreasing the pressure of intake air.

Sol. (c) Brake power of diesel engine can be increased by increasing pressure of intake air.

63. The method of determination of indicated power of multicylinder SI engine is by the use of

- (a) Morse test (b) Prony brake test (c) Motorint test (d) Heat balance test.

Sol. (a) Morse test is used to determine indicated power of multicylinder S.I. engine.



64. Consider the following statements :

As compared to a turboprop, a turbojet

1. can operate at higher altitudes
2. can operate at higher flight velocities
3. is more fuel efficient at lower speeds

Of these statements

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

Sol. (b) Statements 1 and 2 are correct.

65. Propulsion efficiency of a jet engine is given by (where u is flight velocity and V is jet velocity relative to aircraft).

- (a) $2u/V - u$ (b) $V + u/2u$ (c) $2u/V + u$ (d) $V - u/2u$.

Sol. (c) Propulsive efficiency of jet engine = $\frac{2u}{V+u}$

66. In the Orsat flue gas analyser, ammoniacal cuprous chloride is used to absorb.

- (a) CO_2 (b) CO (c) O_2 (d) N_2 .

Sol. (b) In orsat apparatus, ammoniacal cuprous chloride is used to absorb CO .

67. Which one of the following pairs of materials is used as moderators in nuclear reactors ?

- (a) Heavy water and zirconium (b) Zirconium and beryllium
 (c) Cadmium and beryllium (d) Beryllium and heavy water.

Sol. (d) Moderator in nuclear reactor is Beryllium and heavy water.

68. Which one of the following pairs is not correctly matched ?

- (a) Fertile material U-233
 (b) Atomic number ... Number of protons.
 (c) Mass defect.... Binding energy
 (d) Cross-section....Scattering.

Sol. (a) U-233 is not fertile material.

69. The energy released during the fission of one atom of Uranium-235 in million electron volts is about

- (a) 100 (b) 200 (c) 300 (d) 400

Sol. (b) Energy released during fission of U-235 is 200 million electron volt.

70. Dry flue gases with a composition of $\text{CO}_2 = 10.4\%$, $\text{O}_2 = 9.6$ and $\text{N}_2 = 80\%$, indicate that

- (a) excess air is used (b) air is insufficient
 (c) hydrogen is not present in the coal (d) air is just sufficient.

Sol. (a) $\text{O}_2 = 9.6$ means excess air is used.

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

List I (Type of boiler)

- A. Babcock and Wilcox
 B. Lancashire
 C. La-mont
 D. Cochran

List II (Classification of boiler)

1. Forced circulation
 2. Fire tube
 3. Water tube
 4. Vertical

Codes : A B C D

(a) 1 2 3 4

(c) 3 2 1 4

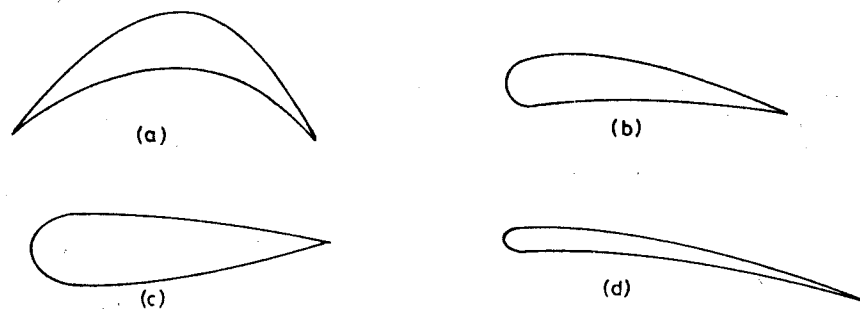
 A B C D

(b) 2 3 4 1

(d) 2 4 1 3

Sol. (c) Correct matching is A-3, B-2, C-1, D-4.

72. Which one of the following sketches represents an impulse turbine blade ?

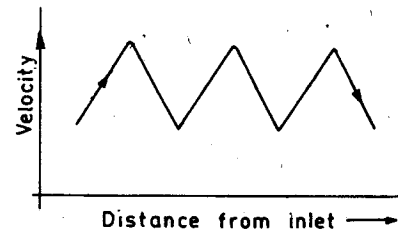


Sol. (a) Figure at (a) is for impulse turbine blade.

73. The graph given in the figure represents the variation absolute velocity of steam along the length of a steam turbine.

The turbine in question is

- (a) Curtis turbine (b) De Laval turbine
(c) Radial turbine (d) Parson's turbine.



Sol. (d) Velocity diagram shown in figure is for Parson's turbine.

74. The correct sequence of the given steam turbines in the ascending order of efficiency at their design points is

- (a) Rateau, De Laval, Parson's, Curtis (b) Curtis, De Laval, Rateau, Parson's.
(c) De Laval, Curtis, Rateau, Parson's (d) Parson's, Curtis, Rateau, De Laval.

Sol. (c) Ascending order for efficiency is De Laval, Curtis, Rateau, Parson's.

75. At which location of a converging - diverging nozzle, does the shock-boundary layer interaction take place ?

- (a) Converging portion (b) Throat (c) Inlet (d) Diverging portion

Sol. (d) Shock-boundary layer interaction takes place in diverging portion of nozzle.

76. The effect of friction in a steam nozzle is to

- (a) increase velocity and increase dryness fraction
(b) increase velocity and decrease dryness fraction
(c) decrease velocity and increase dryness fraction
(d) decrease velocity and decrease dryness fraction.

Sol. (c) Effect of friction in steam nozzle is to decrease velocity and increase dryness fraction.

77. Among other things, the poor part-load performance of De laval turbines is due to the

- (a) formation of shock waves in the nozzle
(b) formation of expansion waves at the nozzle exit
(c) turbulent mixing at the nozzle exit
(d) increased profile losses in the rotor.

Sol. (b) In De Laval turbine, at part load, pressure is reduced but velocity increases which is not fully dropped in single stage. Thus expansion waves occur at nozzle exit.

78. List I gives the various velocities in the velocity diagrams of a two-stage impulse turbine. List II gives the blade angles. Match the velocity from List I with the angle in List II and select the correct answer using the codes given below the lists :

List I

- | | |
|--|-------------------------------------|
| A. Relative velocity of steam at inlet tip of blade | 1. Nozzle angle |
| B. Absolute velocity of steam at inlet tip of blade | 2. Moving blade leading edge angle |
| C. Relative velocity of steam at outlet tip of blade | 3. Moving blade trailing edge angle |
| D. Absolute velocity of steam at outlet tip of blade | 4. Fixed blade leading edge angle. |

List II

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

Sol. (c) Correct matching is A-2, B-1, C-3, D-4.

79. Which one of the following relationship between angles of fixed blades and moving blades corresponds to that of Parson's turbine ?
- (a) $\alpha_1 = \alpha_2$ (b) $\alpha_1 = \beta_2$ (c) $\alpha_2 = \beta_2$ (d) $\beta_1 = \beta_2$

Sol. (b) For Parson s turbine $\alpha_1 = \beta_2$.

80. The following data refer to an axial flow turbine stage:

Relative velocity of steam at inlet to the rotor = 79.0 m/s., Relative velocity at the rotor exit = 152 m/s. rotor mean peripheral velocity = 68.4 m/s, work output per kg. of steam = 14100 J

What is the approximate degree of reaction?

- (a) 0.9 (b) 0.8 (c) 0.7 (d) 0.6

Sol. (d) Enthalpy drop in moving blades = $\frac{V_2^2 - V_1^2}{2 \times 1000} = \frac{152^2 - 79^2}{2000} = \frac{231 \times 73}{2000} = 8.43 \text{ kJ/kg}$

$$\text{Degree of Reaction} = \frac{8.43}{14.1} = 0.597 \cong 0.6$$

81. The clearance flow between the blade tips and casing of a steam turbine is

- (a) greater in the reaction turbine than in the impulse type
 (b) greater in the impulse turbine than in the reaction type.
 (c) independent of the type of the turbine. (d) independent of the size of the turbine.

Sol. (a) Clearance flow between blade tips and casing is greater in reaction turbine due to more differential pressure across stages.

82. The lines *abc* and *cd* in the given graph are known as

- (a) Wilson's line (b) Willan's line
 (c) S.C. line (d) Throttling line

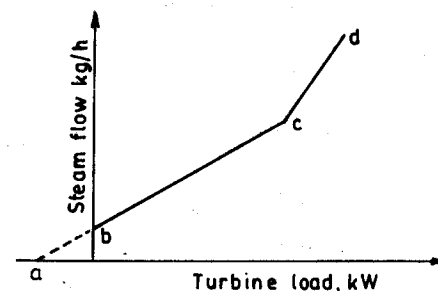
Sol. (a) (a) is right answer.

83. Consider the following statements regarding the nozzle governing of steam turbines:

- Working nozzles receive steam at full pressure
- High efficiency is maintained at all loads
- Stage efficiency suffers due to partial admission
- In practice each nozzle of the first stage is governed individually.

Of these statements

- (a) 1, 2 and 3 are correct (b) 2, 3 and 4 are correct
 (c) 1, 3 and 4 correct (d) 1, 2 and 4 are correct.



Sol. (d) Statements 1, 2, and 4 are correct.

84. Consider the following statements :

1. Boiler mountings are mainly protective devices
2. Steam stop valve is an accessory
3. Feed water pump is an accessory

Of these statements

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

Sol. (c) Statements 2 and 3 are correct.

85. A large clearance volume in a reciprocating compressor results in

- (a) reduced volume flow rate (b) increased volume flow rate
(c) lower suction pressure (d) lower delivery pressure.

Sol. (d) Large clearance volume in reciprocating compressor results in lower delivery pressure.

86. In a reciprocating air compressor the compression work per kg of air.

- (a) increases as clearance volume increases
(b) decreases as clearance volume increases
(c) is independent of clearance volume
(d) increases with clearance volume only for multistage compressor.

Sol. (a) Compression work per kg. of air increases as clearance volume increases.

87. Consider the following statements :

When air is to be compressed to reasonably high pressure, it is usually carried out by a multistage compressor with an intercooler between the stages because

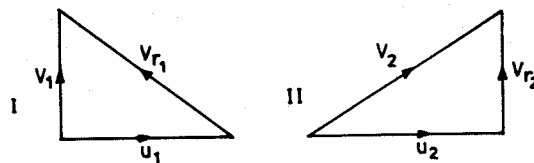
1. work supplied is saved.
2. weight of compressor is reduced.
3. more uniform torque is obtained leading to the reduction in the size of flywheel.
4. volumetric efficiency is increased.

Of the four statements listed above

- (a) 1 alone is correct (b) 2 and 4 are correct
(c) 1, 2 and 3 are correct (d) 1, 2, 3 and 4 are correct.

Sol. (a) Only statement 1 is correct.

88. The inlet and exit velocity diagrams of a turbomachine rotor are shown in the figure I and figure II respectively.



The turbomachine is

- (a) an axial compressor with radial blades
(b) a radial compressor with radial blades.
(c) a radial compressor with forward curved blades
(d) an axial compressor with forward curved blades.

Sol. (a) Velocity diagrams are for axial compressor ($u_1 = u_2$) with radial blades (V_1 and V_{r_2} are perpendicular to u_1 and u_2).

89. In a centrifugal compressor assuming the same overall dimensions, blade inlet angle and rotational speeds, which of the following bladings will give the maximum pressure rise ?
- Forward curved blades
 - Backward curved blades.
 - Radial blades
 - All three types of bladings have the same pressure rise.

Sol. (a) Forward curved blades give maximum pressure rise.

90. Under which one of the following sets of conditions will a supersonic compressor have the highest efficiency ?
- Rotor inlet velocity is supersonic and exit velocity subsonic; stator inlet velocity is subsonic and exit velocity is subsonic.
 - Rotor inlet velocity is supersonic and exit velocity subsonic; stator inlet velocity is supersonic and exit velocity is subsonic.
 - Rotor inlet velocity is supersonic and exit velocity supersonic; stator inlet velocity is supersonic and exit velocity is subsonic.
 - Rotor inlet velocity is supersonic and exit velocity supersonic; stator inlet velocity is subsonic and exit velocity is subsonic.

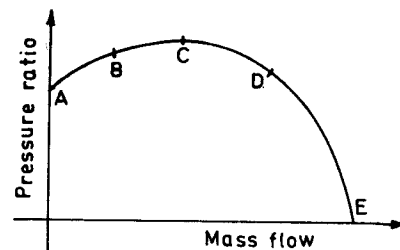
Sol. (c) Statement at (c) is correct.

91. The curve in the given figure shows the variation of theoretical pressure ratio with mass of flow rate for a compressor running at a constant speed.

The permissible operating range of the compressor is represented by the part of the curve from

- A to B
- B to C
- B to D
- D to E

Sol. (c) Curve B to D represents permissible operating range of compressor.



92. The critical value of Mach number for a subsonic airfoil is associated with sharp increase in drag due to local shock formation and its interaction with the boundary layer. A typical value of this critical Mach number is of the order of

- 0.4 to 0.5
- 0.75 to 0.85
- 1.1 to 1.3
- 1.5 to 2.0.

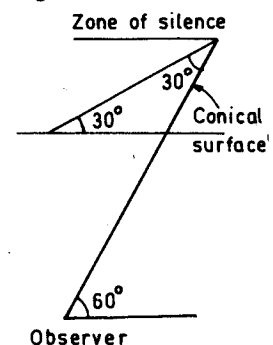
Sol. (c) Critical value of mach number for a subsonic airfoil is 1.1 to 1.3.

93. A supersonic aircraft is ascending at an angle of 30° to the horizontal. When an observer at the ground hears its sound, the aircraft is seen at an elevation of 60° to the horizontal. The flight Mach number of the aircraft is

- $2/\sqrt{3}$
- $\sqrt{3}/2$
- $1/2$
- 2

Sol. (d) Mach angle of the conical surface = 30°

$$\text{Flight mach number of aircraft} = \frac{1}{\sin \alpha} = \frac{1}{\sin 30^\circ} = \frac{1}{1/2} = 2$$

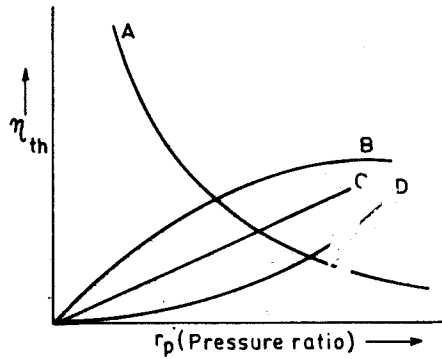


94. In a centrifugal compressor, the highest Mach number leading to shockwave in the fluid flow occurs at

- diffuser inlet radius
- diffuser outlet radius
- impeller inlet radius
- impeller outer radius.

Sol. (b) (b) is right choice.

95. The given figure shows four plots A, B, C and D of thermal efficiency against pressure ratio.



The curve which represents that of a gas turbine plant using Brayton cycle (without regeneration) is the one labelled

- (a) A (b) B (c) C (d) D

Sol. (b) Curve B is for Brayton cycle.

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

List I

- A. Soot Blower
- B. Electrostatic precipitator
- C. Blow down
- D. Zeolite

List II

- 1. Removal of solids from boiler drums
- 2. To clean the tube surfaces of fly ash
- 3. Cleaning of flue gas
- 4. Air cleaning.
- 5. Water purification

Codes : A B C D

(a) 2 4 3 5

(c) 3 2 1 4

 A B C D

(b) 1 3 2 5

(d) 2 3 1 5

Sol. (d) Correct matching is A-2, B-3, C-1, D-5.

97. In which one of the following cases must separation of boundary layer occur ?

- (a) $dp/dx < 0$ (b) $dp/dx = 0$ (c) $dp/dx > 0$
 (d) $dp/dx > 0$ and the velocity profile has a point of inflection.

Sol. (b) Separation of boundary layer occurs when $\frac{dp}{dx} = 0$.

98. Water jacketed copper rod "D" m in diameter is used to carry the current. The water, which flows continuously maintains the rod temperature at T_i °C during normal operation at "I" amps. The electrical resistance of the rod is known to be "R" Ω/m. If the coolant water ceased to be available and the heat removal diminished greatly, the rod would eventually melt. What is the time required for melting to occur if the melting point of the rod material is T_{mp} ? [C_p = specific heat, ρ = density of the rod material and L is the length of the rod].

(a) $\frac{\rho (\pi D^2/4) C_p (T_{mp} - T_i)}{I^2 R}$

(b) $\frac{(T_{mp} - T_i)}{\rho I^2 R}$

(c) $\frac{\rho (T_{mp} - T_i)}{I^2}$

(d) $\frac{C_p (T_{mp} - T_i)}{I^2 R}$

Sol. (a) Correct value of time is as per (a).

99. Consider following parameters:

- 1. Temperature of the surface
- 2. Emissivity of the surface
- 3. Temperature of the air in the room
- 4. Length and diameter of the pipe.

The parameter(s) responsible for loss of heat from a hot pipe surface in a room without fans would include

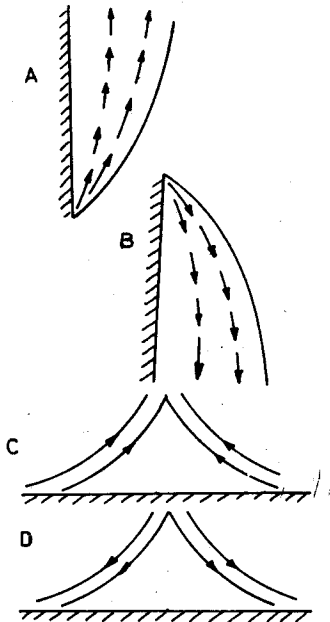
- (a) 1 alone
- (b) 1 and 2
- (c) 1, 2 and 3
- (d) 1, 2, 3 and 4.

Sol. (d) All parameters are responsible for loss of heat from a hot pipe surface.

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

List I (Flow Pattern)

List II (Situation)



- 1. Heated horizontal plate
- 2. Cooled horizontal plate
- 3. Heated vertical plate
- 4. Cooled vertical plate

Codes : A B C D

(a) 4 3 2 1

(c) 3 4 2 1

 A B C D

(b) 3 4 1 2

(d) 4 3 1 2

Sol. (b) Correct matching is A-3, B-4, C-2, D-1.

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

List I

List II

- A. Infinite parallel planes
- B. Completely enclosed body large compared to enclosing body (Subscript 1 for enclosed body)
- C. Two rectangles with common side perpendicular to each other.
- D. Concentric cylinders

- 1. ϵ_1
- 2. $\epsilon_1 \epsilon_2$
- 3. $\frac{1}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1}$
- 4. $\frac{-1}{\frac{1}{\epsilon_1} + \frac{A_1}{A_2} \left(\frac{1}{\epsilon_2} - 1 \right)}$

Codes : A B C D

(a) 1 2 4 3

(c) 2 1 3 4

 A B C D

(b) 3 1 4 2

(d) 3 1 2 4

Sol. (d) Correct matching is A-3, B-1, C-2, D-4.

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

<i>List I</i> (Parameter)	<i>List II</i> (Definition)
A. Time constant of a thermometer of radius r_o	1. hr_o/k_{fluid}
B. Biot number for a sphere of radius r_o	2. k/h
C. Critical thickness of insulation for a wire of radius r_o	3. hr_o/k_{solid}
D. Nusselt number for a sphere of radius r_o	4. $h_2\pi r_o l/\rho cV$

Nomenclature :- h : film heat transfer coefficient, k : thermal conductivity of solid

k_{fluid} : thermal conductivity of fluid, ρ : density, c : specific heat, V : volume, l : length.

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

Sol. (a) Correct matching is A-4, B-3, C-2, D-1.

103. Heat pipe is widely used now-a-days because

- (a) it acts as an insulator
- (b) it acts as conductor and insulator
- (c) it acts as a superconductor
- (d) it acts as a fin.

Sol. (b) Heat pipe can be used in different ways. Insulated portion may be made of flexible tubing to permit accommodation of different physical constraints. It can also be applied to micro-electronic circuits to maintain constant temperature.

It consists of a closed pipe lined with a wicking material and containing a condensable gas. The centre portion of pipe is insulated and its two non-insulated ends respectively serve as evaporators and condensers.

104. A counterflow shell - and - tube exchanger is used to heat water with hot exhaust gases. The water ($C_p = 4180 \text{ J/kg}^\circ\text{C}$) flows at a rate of 2 kg/s while the exhaust gas ($1030 \text{ J/kg}^\circ\text{C}$) flows at the rate of 5.25 kg/s. If the heat transfer surface area is 32.5 m^2 and the overall heat transfer coefficient is $200 \text{ W/m}^2\text{ }^\circ\text{C}$, what is the NTU for the heat exchanger ?

- (a) 1.2
- (b) 2.4
- (c) 4.5
- (d) 8.6.

Sol. (a) $NTU = \frac{AU}{C_{min}} = \frac{32.5 \times 200}{1030 \times 5.25} \cong 1.2$

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

<i>List I</i>	<i>List II</i>
A. Regenerative heat exchanger	1. Water cooling tower
B. Direct contact heat exchanger	2. Lungstrom air heater
C. Conduction through a cylindrical wall	3. Hyperbolic curve
D. Conduction through a spherical wall	4. Logarithmic curve.

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

Sol. (b) Correct matching is A-3, B-1, C-4, D-2.

106. Consider the following statements regarding nucleate boiling :

- 1. The temperature of the surface is greater than the saturation temperature of the liquid.

2. Bubbles are created by the expansion of entrapped gas or vapour at small cavities in the surface.
3. The temperature is greater than that of film boiling.
4. The heat transfer from the surface to the liquid is greater than that in film boiling.

Of these statements

- (a) 1, 2 and 4 correct (b) 1 and 3 are correct
(c) 1, 2 and 3 are correct (d) 2, 3 and 4 are correct.

Sol. (a) Statements 1, 2 and 4 are correct.

107. In current carrying conductors, if the radius of the conductor is less than the critical radius, then addition of electrical insulation is desirable, as

- (a) it reduces the heat loss from the conductor and thereby enables the conductor to carry a higher current.
(b) it increases the heat loss from the conductor and thereby enables the conductor to carry a higher current.
(c) it increases the thermal resistance of the insulation and thereby enables the conductor to carry a higher current.
(d) it reduces the thermal resistance of the insulation and thereby enables the conductor to carry a higher current.

Sol. (a) (a) provides correct answer.

108. The heat flow through a composite cylinder is given by the equation : (symbols have the usual meaning)

$$(a) Q = \frac{(T_1 - T_{n+1}) 2\pi L}{\sum_{n=1}^{n=n} \frac{1}{K_n} \log_e \left(\frac{r_{n+1}}{r_n} \right)}$$

$$(b) Q = \frac{4\pi (T_1 - T_{n+1})}{\sum_{n=1}^{n=n} \left[\frac{r_{n+1} - r_n}{K_n r_n \cdot r_{n+1}} \right]}$$

$$(c) Q = \frac{T_1 - T_{n+1}}{\frac{1}{A} \sum_{n=1}^{n=n} \left(\frac{L_n}{K_n} \right)}$$

$$(d) Q = \frac{T_1 - T_2}{\log_e \frac{r_2}{r_1} / 2\pi K L}$$

Sol. (a) Heat flow is as per equation (a).

109. Match List I (Basic components of Aqua-ammonia refrigeration system) with List II (functions of the components in the system) and select the correct answer using the codes given below the lists :

List I

List II

- | | |
|--------------|--|
| A. Generator | 1. Dehydration. |
| B. Analyser | 2. Removal of vapour from strong aqua-ammonia solution |
| C. Rectifier | 3. Producing dry ammonia vapour by removing traces of water particles completely |
| D. Receiver | 4. Storage of high pressure liquid ammonia |
| | 5. Formation of liquid ammonia from high pressure vapours. |

Codes : A B C D

(a) 3 1 2 4

(c) 1 3 2 5

A B C D

(b) 5 3 4 2

(d) 2 1 3 4

Sol. (d) Correct matching is A-2, B-1, C-3, D-4.

110. A condenser of a refrigeration system rejects heat at a rate of 120 kW, while its compressor consumes a power of 30 kW. The coefficient of performance of the system would be

- (a) 1/4 (b) 1/3 (c) 3 (d) 4.

Sol. (b) Heat rejected in condenser = 120 kW ; Compressor work = 30 kW ;

Net refrigeration effect = 120 - 30 = 90 kW.

$\therefore COP = 30/90 = 1/3$

111. Waste heat can be effectively used in which one of the following refrigeration systems ?

- (a) Vapour compression cycle (b) Vapour absorption cycle.
(c) Air refrigeration cycle (d) Vortex refrigeration system.

Sol. (b) Waste heat can be utilised in vapour absorption cycle.

112. In aircraft, air refrigeration cycle is used because of

- (a) low unit weight per tonne of refrigeration (b) high heat transfer rate.
(c) lower temperature at high-altitudes (d) higher coefficient of performance.

Sol. (a) (a) provides correct reason.

113. A pressure gauge on the discharge side of a refrigerant compressor reads too high. The reasons could be:

1. Lack of cooling water 2. Water temperature being high
3. Dirty condenser surfaces 4. Refrigerant temperature being too high.

Of these reasons

- (a) 1,2 and 4 are valid (b) 1,2 and 3 are valid
(c) 2, 3 and 4 are valid (d) 1, 3 and 4 are valid.

Sol. (b) Reasons at 1,2 and 3 are valid.

114. Consider the following statements :

A decrease in evaporator temperature of a vapour compression machine leads to

1. an increase in refrigerating effect 2. an increase in specific volume of vapour
3. a decrease in volumetric efficiency of compressor
4. an increase in compressor work.

Of these statements

- (a) 1, 3 and 4 are correct (b) 1, 2 and 3 are correct
(c) 2, 3 and 4 are correct (d) 2 and 4 are correct.

Sol. (a) Statements 1,3 and 4 are correct.

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

List I (Refrigerant)

- A. Air
B. Ammonia
C. Carbon dioxide
D. Refrigerant-II

List II (Principal application)

1. Direct contact freezing of food
2. Centrifugal compressor system
3. Large industrial temperature installation
4. Automotive air-conditioners.
5. Aircraft refrigeration

Codes : A B C D

(a) 4 3 1 2

(c) 2 4 3 5

A B C D

(b) 5 3 1 2

(d) 5 3 2 1

Sol. (b) Correct matching is A-5, B-3, C-1, D-2.

116. Consider the following statements :

In psychrometry, wet-bulb temperature is a measure of enthalpy of moist air, so that in the psychrometric chart,

1. the constant enthalpy lines are also constant wet bulb temperature lines
2. the wet bulb and dry bulb temperature are same at any condition
3. the wet - bulb and dry-bulb temperature are equal at saturation condition.

Of these statements.

- (a) 1 alone is correct (b) 1 and 2 are correct
(c) 1 and 3 are correct (d) 2 and 3 are correct.

Sol. (c) Statements 1 and 3 are correct.

117. At 100% relative humidity, the wet bulb temperature is

- (a) more than dew point temperature (b) same as dew point temperature
(c) less than dew point temperature (d) equal to ambient temperature.

Sol. (c) (c) provides correct answer.

118. Two summer air-conditioning systems with non-zero bypass factor are proposed for a room with a known sensible and latent heat load. System A operates with ventilation but system B operates without ventilation. Then the

- (a) bypass factor of system A must be less than the bypass factor of system B
(b) bypass factor of system A must be more than the bypass factor of system B
(c) apparatus dew point for system A must be lower than the apparatus dew point for system B
(d) apparatus dew point for system A must be higher than the apparatus dew point for system B.

Sol. (c) (c) provides correct answer.

119. Evaporative aircooler is used effectively when

- (a) dry bulb temperature is very close to the wet bulb temperature
(b) dry bulb temperature is high and relative humidity is high
(c) dry-bulb temperature is low and relative humidity is high
(d) dry bulb temperature is high and the relative humidity is low.

Sol. (d) (d) is right answer.

120. The minimum temperature to which water can be cooled in a cooling tower is

- (a) the dew point temperature of air (b) the wet bulb temperature of air.
(c) the dry bulb temperature of air (d) the ambient air temperature.

Sol. (a) Water can be cooled in a cooling tower upto dew point temperature of air.

Engineering Services Examination
MECHANICAL ENGINEERING—1995
PAPER-II

-
1. 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.
 2. You have to mark all your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
 3. All items carry equal marks. Attempt all items. Your total marks will depend only on the number of correct responses marked by you in the Answer Sheet.
-

1. In time study, the rating factor is applied to determine
 - (a) standard time of a job
 - (b) merit rating of the worker
 - (c) fixation of incentive rate
 - (d) normal time of a job.

Sol. (b) In time study, the rating factor is applied to determine merit rating of the worker.

2. Work study is mainly aimed at
 - (a) determining the most efficient method of performing a job
 - (b) establishing the minimum time of completion of job
 - (c) developing the standard method and standard time of a job
 - (d) economising the motions involved on the part of the worker while performing a job.

Sol. (a) Work study is mainly aimed at determining the most efficient method of performing a job.

3. Consider the following factors :
 1. Adequate incentive
 2. Ease of administration.
 3. Flexibility
 4. Guaranteed basic pay
 5. Higher wages
 6. Simplicity.

Among these, the factors which are to be considered while developing a good wage incentive plan would include

- (a) 1, 2, 3 and 5 (b) 2, 3, 4 and 5 (c) 1, 2, 4 and 6 (d) 1, 2, 5 and 6.

Sol. (b) Factors 2, 3, 4 and 5 are to be considered in developing a good wage incentive plan.

4. Production cost refers to prime cost plus
 - (a) factory overheads
 - (b) factory and administration overheads
 - (c) factory, administration and sales overheads
 - (d) factory, administration and sales overheads and profit.

Sol. (b) Production cost refers to prime cost plus factory and administrative overheads.

5. For a small scale industry, the fixed cost per month is Rs. 5000/-. The variable cost per product is Rs. 20/- and sales price is Rs. 30/- per piece. The break-even production per month will be
 - (a) 300
 - (b) 460
 - (c) 500
 - (d) 10000

Sol. (c) Break even production per month is 500.

6. Which one of the following methods can be used for forecasting the sales potential of a new product ?
 - (a) Time series analysis
 - (b) Jury of Executive Opinion method
 - (c) Sales Force Composite method
 - (d) Direct Survey method.

Sol. (d) Direct survey method can be used for forecasting the sales potential of a new product.

7. Which of the following charts are used for plant layout design ?

- | | |
|----------------------------|----------------------|
| 1. Operation process chart | 2. Man machine chart |
| 3. Correlation chart | 4. Travel chart. |

Select the correct answer using the codes given below :

Codes :

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

Sol. (b) Charts at 1, 2 and 4 are used for plant layout design.

8. Classifying items in A, B and C categories for selective control in inventory management is done by arranging items in the decreasing order of

- | | |
|---------------------------|------------------|
| (a) total inventory costs | (b) item value |
| (c) annual usage value | (d) item demand. |

Sol. (a) Answer at (a) is correct.

9. In manufacturing management, the term "Despatching" is used to describe

- | | |
|--|---|
| (a) despatch of sales order | (b) despatch of factory mail |
| (c) despatch of finished product to the user | (d) despatch of work orders through shop floor. |

Sol. (d) Despatching is used to dispatch work orders through shop floor.

10. Which of the following factors are to be considered for production scheduling ?

- | | |
|-------------------|---------------------|
| 1. Sales forecast | 2. Component design |
| 3. Route sheet | 4. Time standards. |

Select the correct answer using the codes given below :

Codes :

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

Sol. (d) Factors at 2, 3 and 4 are to be considered for production scheduling.

11. Consider the following statements :

- | | |
|--|---|
| 1. ABC analysis is based on Pareto's principle. | 2. FIFO and LIFO policies can be used for material valuation in materials management. |
| 3. Simulation can be used for inventory control. | 4. EOQ (Economic Order Quantity) formula ignores variations in demand pattern. |

Of these statements

- | | |
|-----------------------------|--------------------------------|
| (a) 1 alone is correct | (b) 1 and 3 are correct |
| (c) 2, 3 and 4 are correct. | (d) 1, 2, 3 and 4 are correct. |

Sol. (d) All four statements are correct.

12. A device for lifting or lowering objects suspended from a hook at the end of a retractable chain or cable is called

- | | | | |
|-----------|---------------|--------------------|---------------|
| (a) hoist | (b) jib crane | (c) chain conveyor | (d) elevator. |
|-----------|---------------|--------------------|---------------|

Sol. (a) Hoist is right answer.

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

List I (O.R. techniques)

List II (Application)

- | | |
|-----------------------|---------------------------------|
| A. Linear programming | 1. Warehouse location decision. |
| B. Transportation | 2. Machine allocation decision. |
| C. Assignment | 3. Product mix decision. |
| D. Queueing theory | 4. Project management decision |
| | 5. Number of servers decision. |

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

Sol. (a) Correct matching is A-1, B-2, C-3 and D-5.

14. In inventory control theory, the economic order quantity (E.O.Q.) is

- (a) average level of inventory.
- (b) optimum lot size.
- (c) lot size corresponding to break-even analysis.
- (d) capacity of a warehouse.

Sol. (b) In inventory control theory the economic order quantity is optimum lot size.

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

	<i>List I</i>					<i>List II</i>			
	A.	Linear programming				1.	Ritchie		
	B.	Dynamic programming				2.	Dantzig.		
	C.	'C' programming				3.	Bell.		
	D.	Integer programming				4.	Gomory		
Codes :	A	B	C	D		A	B	C	D
(a)	2	1	4	3	(b)	1	2	3	4
(c)	2	3	1	4	(d)	2	3	4	1

Sol. (c) Correct matching is A-2, B-3, C-1, D-4.

16. The solution in a transportation model (of dimension $m \times n$) is said to be degenerate if it has

- (a) exactly $(m + n - 1)$ allocations
- (b) fewer than $(m + n - 1)$ allocations
- (c) more than $(m + n - 1)$ allocations
- (d) $(m \times n)$ allocations.

Sol. (b) (b) is right choice.

17. In value engineering important consideration is given to

- (a) cost reduction
- (b) profit maximisation.
- (c) function concept
- (d) customer satisfaction.

Sol. (d) In value engineering important consideration is given to customer satisfaction.

18. In a computer application where a direct dialogue is carried on between the computer and the user is referred to as

- (a) interfacing
- (b) batch processing
- (c) decision application
- (d) real-time application.

Sol. (d) 'Real time application' is right choice.

19. Which one of the following software packages is used for plant layout ?

- (a) SIMSCRIPT
- (b) DYNAMO
- (c) CRAFT
- (d) MRP.

Sol. (c) CRAFT software is used for plant layout.

Directions : The following fourteen items consist of two statements, one labelled the 'Assertion A' and the other labelled the 'Reason R'. You are to examine these two statements carefully and decide if the Assertion A and the Reason R are individually true and if so, whether the Reason is a correct explanation of the Assertion. Select your answer to these items using the codes given below and mark your answer sheet accordingly.

Codes :

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not a correct explanation of A.
- (c) A is true but R is false
- (d) A is false but R is true.

- 20. Assertion (A) :** The elements of higher pairs must be force closed.
Reason (R) : This is required in order to provide completely constrained motion.
Sol. (a) Elements of higher pairs must be force closed to provide completely constrained motion.
- 21. Assertion (A) :** Crossed helical gears for skew shafts are not used to transmit heavy loads.
Reason (R) : The gears have a point contact, and hence are not considered strong.
Sol. (a) Crossed helical gears for skew shafts are not used to transmit heavy loads because gears have point contact and are not strong.
- 22. Assertion (A) :** In equilibrium position, the journal inside a journal bearing remains floating on the oil film.
Reason (R) : In a journal bearing, the load on the bearing is perpendicular to the axis of the journal.
Sol. (b) Both A and R are true but R is not correct explanation for A.
- 23. Assertion (A) :** Two concentric helical springs used to provide greater spring force are wound in opposite directions.
Reason (R) : The winding in opposite directions in the case of helical springs prevents buckling.
Sol. (a) Two concentric helical springs used to provide greater spring force are wound in opposite direction to prevent buckling.
- 24. Assertion (A) :** Circular shafts made of brittle material fail along a helicoidal surface inclined at 45 deg. to the axis (artery point) when subjected to twisting moment.
Reason (R) : The state of pure shear caused by torsion of the shaft is equivalent to one of tension at 45 deg. to the shaft axis and equal compression in the perpendicular direction.
Sol. (a) Both A and R are true and R is correct explanation for A.
- 25. Assertion (A) :** In an I-section beam subjected to concentrated loads, the shearing force at any section of the beam is resisted mainly by the web portion.
Reason (R) : Average value of the shearing stress in the web is equal to the value of shearing stress in the flange.
Sol. (c) A is true but R is false.
- 26. Assertion (A) :** Non-ferrous materials are best machined with diamond tools.
Reason (R) : Diamond tools are suitable for high speed machining.
Sol. (d) A is false and R is true.
- 27. Assertion (A) :** A chip breaker is employed to improve the machinability of brass.
Reason (R) : A chip breaker facilitates the curling and breakage of long continuous chips.
Sol. (a) Chip breaker is employed to improve machinability of brass as it facilitates the curling and breakage of long continuous chips.
- 28. Assertion (A) :** Up milling or climb milling is commonly used for machining castings and forgings.
Reason (R) : Up milling can be done on universal milling machines.
Sol. (d) A is false but R is true.
- 29. Assertion (A) :** Aluminium alloys are cast in hot chamber die casting machine.
Reason (R) : Aluminium alloys require high melting when compared to zinc alloys.
Sol. (a) Aluminium alloys are cast in hot chamber die casting machine because of high melting temperature.

30. Assertion (A) : In a Swiss - type automatic lathe, the turret is given longitudinal feed for each tool in a specific order with suitable indexing.

Reason (R) : A turret is a multiple tool holder to facilitate machining with each tool by indexing without the need to change the tools.

Sol. (b) Both A and R are true, but R does not provide correct explanation for A.

31. Assertion (A) : An aluminium alloy with 11 % silicon is used for making engine-pistons by die casting technique.

Reason (R) : Aluminium has low density and addition of silicon improves its fluidity and therefore its castability.

Sol. (a) Both are true and R is correct explanation for A.

32. Assertion (A) : Product layout is more amenable to automation than process layout.

Reason (R) : The work to be performed on the product is the determining factor in the positioning of the manufacturing equipment in product layout.

Sol. (a) Both are true and R is correct explanation for A.

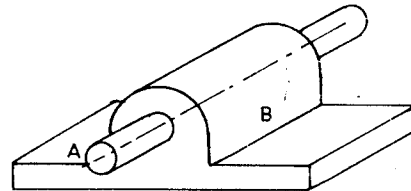
33. Assertion (A) : In a queueing model, the assumption of exponential distribution with only one parameter family for service times is found to be unduly restrictive.

Reason (R) : This is partly because the exponential distribution has the property that smaller service times are inherently less probable than larger service times.

Sol. (a) Both are true and R is correct explanation for A.

34. A round bar A passes through the cylindrical hole in B as shown in the given figure. Which one of the following statements is correct in this regard ?

- (a) The two links shown form a kinematic pair.
- (b) The pair is completely constrained.
- (c) The pair has incomplete constraint.
- (d) The pair is successfully constrained.



Sol. (b) The pair in the figure is completely constrained.

35. The instantaneous centre of rotation of a rigid thin disc rolling on a plane rigid surface is located at

- (a) the centre of the disc.
- (b) an infinite distance on the plane surface.
- (c) the point of contact.
- (d) the point on the circumference situated vertically opposite to the contact point.

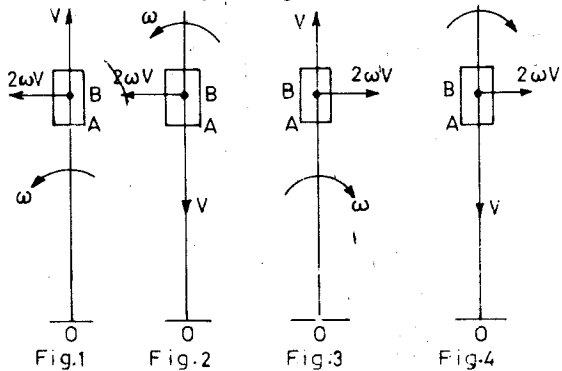
Sol. (a) The instantaneous centre of rotation of a rigid thin disc rolling on a plane rigid surface is located at the point of contact.

36. The directions of Coriolis component of acceleration, $2\omega V$, of the slider A with respect to the coincident point B is shown in figures 1, 2, 3 and 4.

Directions shown by figures

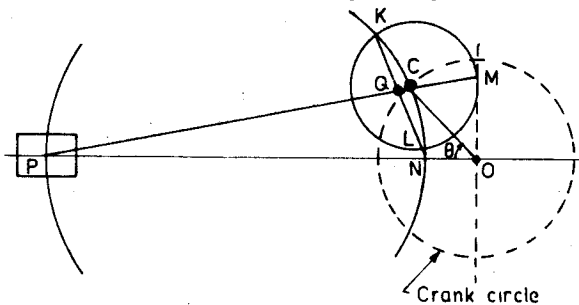
- (a) 2 and 4 are wrong
- (b) 1 and 2 are wrong
- (c) 1 and 3 are wrong
- (d) 2 and 3 are wrong

Sol. (a) Directions of coriolis component shown in figure 2 and 4 are wrong.



37. Klein's construction for determining the acceleration of piston P is shown in the given figure. When N coincides with

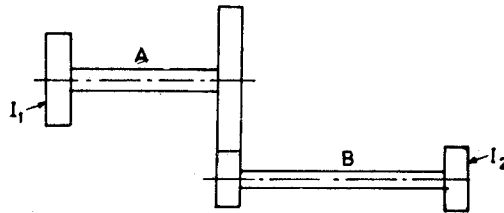
- acceleration of piston is zero and its velocity is zero.
- acceleration is maximum and velocity is maximum.
- acceleration is maximum and velocity is zero.
- acceleration is zero and velocity is maximum.



Sol. (d) (d) is right choice.

38. A torsional system with discs of moment of inertia I_1 and I_2 , shown in the given figure, is gear driven such that the ratio of the speed of shaft B to shaft A is ' n '. Neglecting the inertia of gears, the equivalent inertia of disc on B at the speed of shaft A is equal to

- nI_2
- n^2I_2
- I_2/n^2
- I_2/n



Sol. (b) (b) is right choice.

39. Which one of the following pairs is not correctly matched ?

- Positive drive Belt drive
- High velocity ratio Worm gearing
- To connect non-parallel and non-intersecting shafts Spiral gearing.
- Diminished noise and smooth operation Helical gears.

Sol. (a) First pair is rightly matched.

40. Consider the following expressions for a spur gear :

- Addendum = $1/p_d$
- Clearance = $p_c/20$
- Centre distance for internal gears = $T_1 + T_2/2P_d$
- Dedendum = $1.157 p_c/\pi$

Of these expressions

- 1, 2, 3 and 4 are correct
- 1 and 2 are correct
- 1, 2 and 3 are correct
- 1, 2 and 4 are correct.

Sol. (d) Babbit lining is used on brass / bronze bearing to increase wear resistance.

41. Babbit lining is used on brass/bronze bearings to

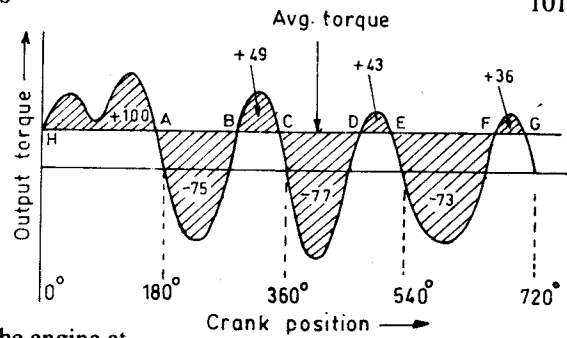
- increase bearing resistance
- increase compressive strength
- provide antifriction properties
- increase wear resistance.

42. In an oil-lubricated journal bearing, coefficient of friction between the journal and the bearing.

- remains constant at all speeds.
- is minimum at zero speed and increases monotonically with increase in speed.
- is maximum at zero speed and decreases monotonically with increase in speed.
- becomes minimum at an optimum speed and then increases with further increase in speed.

Sol. (d) (d) is right choice.

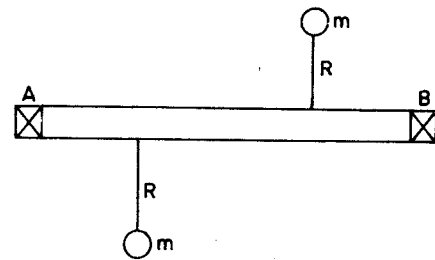
43. The given figure shows the output torque plotted against crank positions for a single cylinder four-stroke-cycle engine. The areas lying above the zero-torque line represent positive work and the areas below represent negative work. The engine drives a machine which offers a resisting torque equal to the average torque. The relative magnitudes of the hatched areas are given by the numbers (in the areas) as shown:



During the cycle, the minimum speed occurs in the engine at

- (a) B (b) D
(c) H (d) F
- Sol. (d) Minimum speed occurs at point where cumulative torque is least, i.e. -23 at F.
44. For a spring controlled governor to be stable, the controlling force (F) is related to the radius (r) by the equation.
- (a) $F = ar - b$ (b) $F = ar + b$ (c) $F = ar$ (d) $F = a/r + b$.
- Sol. (a) $F = ar - b$ for stable governor.

45. A rotor supported at A and B , carries two masses as shown in the given figure. The rotor is
- (a) dynamically balanced
(b) statically balanced
(c) statically and dynamically balanced
(d) not balanced.



- Sol. (d) The rotor in given figure is not balanced because couple formed is not taken care of.

46. The equation of free vibrations of a system is $\ddot{X} + 36\pi^2 X = 0$. Its natural frequency is
- (a) 6 Hz (b) 3π Hz (c) 3 Hz (d) 6π Hz.

Sol. (d) Natural frequency $\sqrt{36\pi^2/1} = 6\pi$

47. Which of the following methods can be used to determine the damping of machine element ?
1. Logarithmic method
 2. Band-width method
 3. Rayleigh method
 4. Holzer method.

Select the correct answer using the codes given below :

Codes :

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

Sol. (b) Methods at 1 and 2 are used.

48. If $\omega/\omega_n = \sqrt{2}$, where ω is the frequency of excitation and ω_n is the natural frequency of vibrations, then the transmissibility of vibrations will be

- (a) 0.5 (b) 1.0 (c) 1.5 (d) 2.0.

Sol. (b) Transmissibility of vibration is 1 when $\omega/\omega_n = \sqrt{2}$.

49. A slender shaft supported on two bearings at its ends carries a disc with an eccentricity e from the axis of rotation. The critical speed of the shaft is N . If the disc is replaced by a second one of same weight but mounted with an eccentricity $2e$, critical speed of the shaft in the second case is

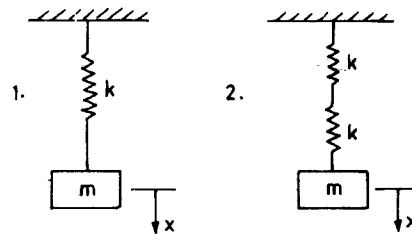
- (a) $1/2N$ (b) $1/\sqrt{2} N$ (c) N (d) $2N$.

Sol. (b) (b) is right answer.

50. For the spring-mass system shown in the figure 1, the frequency of vibration is N . What will be the frequency when one more similar spring is added in series, as shown in figure 2 ?

- (a) $N/2$ (b) $N/\sqrt{2}$
 (c) $\sqrt{2}/N$ (d) $2N$.

Sol. (b) (b) is right answer.



51. Which one of the following is true for involute gears ?

- (a) Interference is inherently absent
 (b) Variation in centre distance of shafts increases radial force
 (c) A convex flank is always in contact with concave flank
 (d) Pressure angle is constant throughout the teeth engagement.

Sol. (d) For involute gears, the pressure angle is constant throughout the teeth engagement.

52. The gear train usually employed in clocks is a

- (a) reverted gear train (b) simple gear train
 (c) sun and planet gear (d) differential gear.

Sol. (b) Reverted gear train is used in clocks.

53. The load cup of a screw jack is made separate from the head of the spindle to

- (a) enhance the load carrying capacity of the jack
 (b) reduce the effort needed for lifting the working load
 (c) reduce the value of frictional torque required to be countered for lifting the load
 (d) prevent the rotation of load being lifted.

Sol. (d) Load cup prevents the rotating of load.

54. A bolt of uniform strength can be developed by

- (a) keeping the core diameter of threads equal to the diameter of unthreaded portion of the bolt
 (b) keeping the core diameter smaller than the diameter of the unthreaded portion
 (c) keeping the nominal diameter of threads equal the diameter of unthreaded portion of the bolt
 (d) one end fixed and the other end free.

Sol. (a) A bolt of uniform strength can be developed by keeping core diameter equal to diameter at unthreaded portion.

55. While designing a screw in a screw jack against buckling failure, the end conditions for the screw are taken as

- (a) both the ends fixed (b) both the ends hinged
 (c) one end fixed and other end hinged (d) one end fixed and the other end free.

Sol. (d) (d) is right choice.

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

List I

(Different types of detachable joints)

- A. Cotter joint
 B. Knuckle joint
 C. Suspension link joint
 D. Turn buckle (adjustable joint).

List II

(Specific use of these detachable joints).

1. Tie rod of a wall crane
 2. Suspension bridges
 3. Diagonal stays in boiler
 4. Cross-head of a steam engine.

Codes : A B C D

(a) 4 2 3 1

(c) 3 2 1 4

A B C D

(b) 4 3 2 1

(d) 2 1 4 3

Sol. (b) Correct matching is A-4, B-3, C-2, D-1.

57. A spur gear transmitting power is connected to the shaft with a key of rectangular section. The type (s) of stresses developed in the key is /are.

- (a) shear stress alone (b) bearing stress alone
(c) both shear and bearing stresses (d) shearing, bearing and bending stresses.

Sol. (c) Key develops both shear and bearing stresses.

58. The permissible stress in a filled weld is 100 N/mm^2 . The fillet weld has equal leg lengths of 15 mm each. The allowable shearing load on weldment per cm length of the weld is

- (a) 22.5 kN (b) 15.0 kN (c) 10.6 kN (d) 7.5 kN.

Sol. (c) Load allowed = $100 \times 0.707 \times 10 \times 15 = 10.6 \text{ kN}$

59. Sources of power loss in a chain drive are given below:

- Friction between chain and sprocket teeth.
- Overcoming the chain stiffness.
- Overcoming the friction in shaft bearing.
- Frictional resistance to the motion of the chain in air or lubricant.

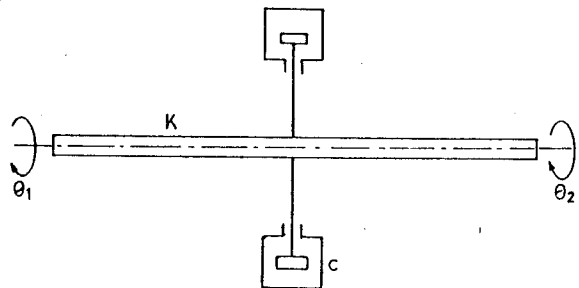
The correct sequence of descending order of power loss due to these sources is

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

Sol. (a) Power loss in descending order takes place as 1, 2, 3 and 4.

60. Given figure shows a flexible shaft of negligible mass of torsional stiffness K coupled to a viscous damper having a coefficient of viscous damping c . If at any instant the left and right ends of this shaft have angular displacements θ_1 and θ_2 respectively, then the transfer function, θ_2/θ_1 of the system is

- (a) $\frac{K}{K+c}$ (b) $\frac{1}{1 + \frac{c}{K}s}$
(c) $\frac{1}{1 + \frac{K}{c}s}$ (d) $1 + \frac{K}{c}s$.



Sol. (b) (b) is right transfer function.

61. Consider the following design considerations :

- Tensile failure
- Creep failure
- Bearing failure
- Shearing failure.
- Bending failure

The design of the pin of a rocker arm of an I.C. engine is based on

- (a) 1, 2 and 4 (b) 1, 3 and 4 (c) 2, 3 and 5 (d) 3, 4 and 5.

Sol. (d) Design of pin of a rocker arm of an I.C. engine is based on bearing, shearing, and bending failures.

62. Which one of the following loadings is considered for design of axles?

- (a) Bending moment only
(b) Twisting moment only
(c) Combined bending moment and torsion
(d) Combined action of bending moment, twisting moment and axial thrust.

Sol. (c) Combined bending moment and torsion are considered to design axles.

63. Removal of metal particles from the raceway of a rolling contact bearing is a kind of failure of bearing known as

- (a) pitting (b) wearing (c) spalling (d) scuffing.

Sol. (a) Pitting is right answer.

64. The design calculations for members subject to fluctuating loads with the same factor of safety yield the most conservative estimates when using

- (a) Gerber relation (b) Soderberg relation
(c) Goodman relation (d) none of the above.

Sol. (b) (b) is right choice.

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

List I

- A. Crank shaft
B. Wire shaft
C. Axle
D. Plain shaft

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

List II

- Supports the revolving parts and transmits torque.
- Transmits motion between shafts where it is not possible to effect a rigid coupling between them.
- Converts linear motion into rotary motion.
- Supports only the revolving parts.

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

Sol. (a) Correct matching is A-3, B-2, C-1, D-4.

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

List I (Terminology)

- A. Interference
B. Dynamic load on tooth
C. Static load
D. Contact ratio

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

List II (Relevant terms)

- Arc of approach, arc of recess, circular pitch.
- Lewis equation.
- Minimum number of teeth on pinion.
- Inaccuracies in tooth profile.

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

Sol. (d) Correct matching is A-3, B-4, C-2, D-1.

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

List I (Name)

- A. Oldham coupling
B. Flange coupling
C. Universal coupling
D. Friction coupling

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

List II (Type)

- Joins collinear shafts and is of rigid type.
- Joins non-collinear shafts and is adjustable.
- Joins collinear shafts and engages and disengages them during motion.
- Compensates peripheral shafts, longitudinal and angular shifts of shafts.

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

Sol. (a) Correct matching is A-2, B-1, C-4, D-3.

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

List I (Requirement)

- A. High temperature service.
B. High load
C. No lubrication
D. Bushings

List II (Type)

- Teflon bearing.
- Carbon bearing
- Hydrodynamic bearing
- Sleeve bearing

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

Sol. (d) Correct matching is A-2, B-3, C-1, D-4.

69. In the calculation of induced shear stress in helical springs, the Wahl's correction factor is used to take care of

- (a) combined effect of transverse shear stress and bending stress in the wire.
- (b) combined effect of bending stress and curvature of the wire.
- (c) combined effect of transverse shear stress and curvature of the wire.
- (d) combined effect of torsional shear stress and transverse shear stress in the wire.

Sol. (c) Wahl's factor is used to take care of (c).

70. Hoop stress and longitudinal stress in a boiler shell under internal pressure are 100 MN/m^2 and 50 MN/m^2 respectively. Young's modulus of elasticity and Poisson's ratio of the shell material are 200 GN/m^2 and 0.3 respectively. The hoop strain in boiler shell is

- (a) 0.425×10^{-3}
- (b) 0.5×10^{-3}
- (c) 0.585×10^{-3}
- (d) 0.75×10^{-3}

Sol. (a) $100 = \frac{pd}{2t}$, Hoop strain $= \frac{1}{E} \left(f_h - \frac{1}{m} f_c \right) = \frac{1}{200 \times 1000} [100 - 0.3 \times 50] = \frac{85}{200} \times 10^{-3} = 0.425 \times 10^{-3}$

71. The stretch in a steel rod of circular section, having a length 'l' subjected to a tensile load 'P' and tapering uniformly from a diameter d_1 at one end to a diameter d_2 at the other end, is given

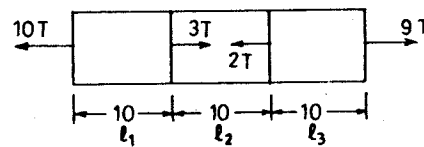
- (a) $P \cdot l / 4 E d_1 \cdot d_2$
- (b) $Pl \cdot \pi / E \cdot d_1 \cdot d_2$
- (c) $Pl / 4E (d_1 \cdot d_2)$
- (d) $4P \cdot l / \pi \cdot E \cdot d_1 \cdot d_2$

Sol. (d) (d) is right answer.

72. The total extension of the bar loaded as shown in the figure is

A = area of cross-section
E = modulus of elasticity

- (a) $10 \times 30 / AE$
- (b) $26 \times 10 / AE$
- (c) $9 \times 30 / AE$
- (d) $30 \times 22 / AE$



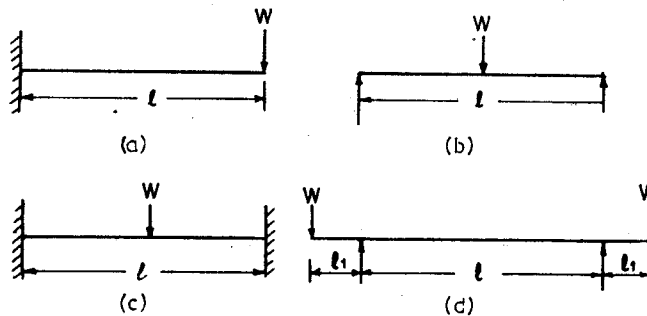
Sol. (c) Net load is $[(10-3) + (-3-2) + (9-2)] = 9$; \therefore Extension $= 9 \times 30 / AE$

73. If Poisson's ratio for a material is 0.5, then the elastic modulus for the material is

- (a) three times its shear modulus
- (b) for times its shear modulus
- (c) equal to its shear modulus
- (d) indeterminate.

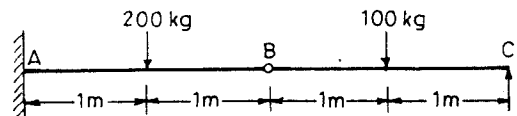
Sol. (a) (a) is right choice.

74. Constant bending moment over span "l" will occur in



Sol. (c) (c) is right choice.

75. The given figure shows a beam BC simply supported at C and hinged at B (free end) of a cantilever AB . The beam and the cantilever carry forces of 100 kg and 200 kg respectively. The bending moment at B is



- (a) zero (b) 100 kg-m
(c) 150 kg-m (d) 200 kg-m.

Sol. (a) BM at B is zero.

76. A rectangular section beam subjected to a bending moment M varying along its length is required to develop same maximum bending stress at any cross-section. If the depth of the section is constant, then its width will vary as

- (a) M (b) \sqrt{M} (c) M^2 (d) $1/M$

Sol. (a) Width will vary proportional to M .

77. Consider the following statements :

If at a section distant from one of the ends of the beam, M represents the bending moment, V the shear force and w the intensity of loading, then

1. $dM/dx = V$ 2. $dV/dx = w$
3. $dw/dx = y$ (the deflection of the beam at the section)

Of these statements

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

Sol. (a) Statements 1 and 3 are correct.

78. A cantilever beam having 5 m length is so loaded that it develops a shearing force of 20T and a bending moment of 20 T-m at a section 2m from the free end. Max shearing force and max. bending moment developed in the beam, under this load, are respectively 50 T and 125 T-m. The load on the beam is

- (a) 25 T concentrated load at free end. (b) 20T concentrated load at free end.
(c) 5T concentrated load at free end and 2 T/m load over entire length.
(d) 10 T/m udl over entire length.

Sol. (d) 10 T/m uniformly distributed load over entire length.

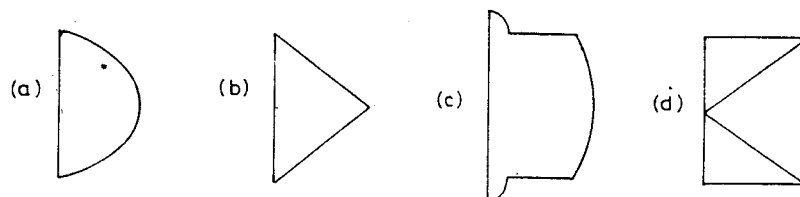
79. A beam having uniform cross-section carries a uniformly distributed load of intensity q per unit length over its entire span, and its mid-span deflection is δ .

The value of mid-span deflection of the same beam when the same load is distributed with intensity varying from $2q$ unit length at one end to zero at the other end is

- (a) $1/3 \delta$ (b) $1/2 \delta$ (c) $2/3 \delta$ (d) δ .

Sol. (c)

80. In a beam of circular cross-section, the shear stress variation across a cross-section is



Sol. (a)

81. A simply supported beam carrying a concentrated load W at mid-span deflects by δ_1 under the load. If the same beam carries the load W such that it is distributed uniformly over entire length and undergoes a deflection δ_2 at the mid span. The ratio $\delta_1 : \delta_2$ is

- (a) 2 : 1 (b) $\sqrt{2} : 1$ (c) 1 : 1 (d) 1 : 2.

Sol. (b)

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

List I (End conditions of columns)

List II (Lowest critical load)

- | | |
|---|----------------------|
| A. Column with both ends hinged | 1. $(\pi^2 EI)/L^2$ |
| B. Column with both ends fixed | 2. $(2\pi^2 EI)/L^2$ |
| C. Column with one end fixed and the other end hinged | 3. $(4\pi^2 EI)/L^2$ |
| D. Column with one end fixed and the other end free | 4. $(\pi^2 EI)/4L^2$ |

(E is the Young's modulus of elasticity of column material, L is the length and I is the second moment of area of cross-section of the column.)

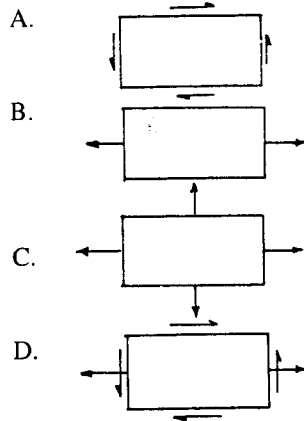
Codes :	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	3	2	1	4
(c)	1	3	2	4	(d)	2	4	3	1

Sol. (c)

83. Match List I with List II and select the correct answer, using the codes given below the lists :

List I (State of stress)

List II (Kind of loading)



1. Combined bending and torsion of circular shaft.
2. Torsion of circular shaft.
3. Thin cylinder subjected to internal pressure.
4. Tie bar subjected to tensile force.

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

Sol. (c)

84. A 3-meter long steel cylindrical shaft is rigidly held at its two ends. A pulley is mounted on the shaft at 1 meter from one end; the shaft is twisted by applying torque on the pulley.

The maximum shearing stresses developed in 1 m and 2 m lengths are respectively τ_1 and τ_2 . The ratio $\tau_2 : \tau_1$ is

- (a) $1/2 \tau$ (b) τ (c) 2τ (d) 4τ .

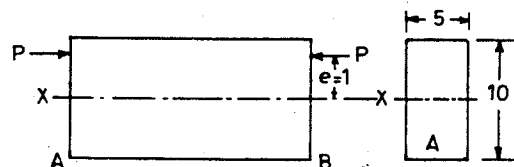
Sol. (b)

85. A closely-coiled helical spring is acted upon by an axial force. The maximum shear stress developed in the spring is τ . Half of the length of the spring is cut off and the remaining spring is acted upon by the same axial force. The maximum shear stress in the spring the new condition will be
 (a) $1/2 \tau$ (b) τ (c) 2τ (d) 4τ .

Sol. (b)

86. For the configuration of loading shown in the given figure, the stress in fibre AB is given by

- (a) P/A (tensile)
 (b) $\left(\frac{P}{A} - \frac{P \cdot e \cdot 5}{I_{xx}}\right)$ (compressive)
 (c) $\left(\frac{P}{A} + \frac{P \cdot e \cdot 5}{I_{xx}}\right)$ (compressive)
 (d) P/A (Compressive).



Sol. (b)

87. Permissible bending moment in a circular shaft under pure bending is M according to maximum principal stress theory of failure. According to maximum shear stress theory of failure, the permissible bending moment in the same shaft is

- (a) $1/2 M$ (b) M (c) $\sqrt{2} M$ (d) $2M$.

Sol. (a)

88. In low carbon steels, presence of small quantities sulphur improves

- (a) weldability (b) formability (c) machinability (d) hardenability.

Sol. (c)

89. Consider the following statements :

Addition of silicon to cast iron

1. promotes graphite module formation.
2. promotes graphite flake formation.
3. increases the fluidity of the molten metal.
4. improves the ductility of cast iron.

Of these statements

- (a) 1 and 4 correct (b) 2 and 3 are correct
 (c) 1 and 3 are correct (d) 3 and 4 are correct.

Sol. (b)

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

List I (Heat treatment)

- A. Annealing
 B. Nitriding
 C. Martempering
 D. Normalising

Codes : A B C D

- (a) 4 3 2 1
 (c) 4 2 1 3

List II (Effect on the properties)

1. Refined grain structure
2. Improves the hardness of the whole mass
3. Increases surface hardness
4. Improves ductility.

A B C D

- (b) 1 3 4 2
 (d) 2 1 3 4

Sol. (a)

91. Eutectoid reaction occurs at

- (a) 600°C (b) 723°C (c) 1147°C (d) 1493°C.

Sol. (d)

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

List I (Name of Material)

List II (% Carbon Range)

- A. Hypo-eutectoid steel
B. Hyper-eutectoid steel
C. Hypo-eutectic cast iron
D. Hyper-eutectic cast iron

1. 4.3 – 6.67
2. 2.0 – 4.3
3. 0.8 – 2.0.
4. 0.008 – 0.8.

Codes : A B C D

- (a) 4 3 2 1
(c) 4 1 2 3

A B C D

- (b) 1 3 2 4
(d) 1 2 3 4

Sol. (a)

93. Which one of the following sets of constituents is expected in equilibrium cooling of a hypereutectoid steel from austenitic state ?

- (a) Ferrite and pearlite. (b) Cementite and pearlite.
(c) Ferrite and bainite. (d) Cementite and martensite.

Sol. (b)

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

List I (Alloy)

List II (Use)

- A. Low carbon steel
B. Hadfield manganese steel
C. Constantan
D. Babbit alloy

1. Bearing.
2. Thermocouple
3. Wire nails.
4. Bulldozer blades.

Codes : A B C D

- (a) 1 2 3 4
(c) 3 2 1 4

A B C D

- (b) 3 4 1 2
(d) 3 4 2 1

Sol. (d)

95. The structure of a polymer is shown in the given figure. This polymer finds special application in

- (a) packaging
(b) adhesives
(c) bearings
(d) fertilizer.

Sol. (c)

96. The angle between the face and the flank of the single point cutting tool is known as

- (a) rake angle (b) clearance angle (c) lip angle (d) point angle.

Sol. (c)

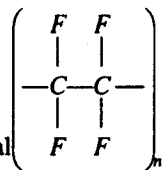
97. Single point thread cutting tool should ideally have

- (a) zero rake (b) positive rake (c) negative rake (d) normal rake.

Sol. (a)

98. Consider the following statements about nose radius

1. It improves tool life. 2. It reduces the cutting force.



3. It improves the surface finish.

Of these statements

(a) 1 and 2 are correct

(b) 2 and 3 are correct

(c) 1 and 3 are correct

(d) 1, 2 and 3 are correct.

Sol. (d)

99. The compositions of some of the alloy steels are as under:

1. 18 W 4 Cr 1 V

2. 12 Mo 1 W 4 Cr 1 V

3. 6 Mo 6 W 4 Cr 1 V

4. 18 W 8 Cr 1 V.

The compositions of commonly used high-speed steels would include

(a) 1 and 2

(b) 2 and 3

(c) 1 and 4

(d) 1 and 3.

Sol. (c)

100. The straight grades of cemented carbide cutting tool materials contain

(a) tungsten carbide only

(b) tungsten carbide and titanium carbide

(c) tungsten carbide and cobalt

(d) tungsten carbide and cobalt carbide.

Sol. (c)

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

List I (Wear type)

- A. Abrasive wear
- B. Adhesive wear
- C. Electrolytic wear
- D. Diffusion wear

List II (Associated mechanism)

- 1. Galvanic action
- 2. Ploughing action
- 3. Molecular transfer
- 4. Plastic deformation
- 5. Metallic bond.

Codes :

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

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

Sol. (a)

102. Crater wear is predominant in

(a) carbon steel tools

(b) tungsten carbide tools

(c) high speed steel tools

(d) ceramic tools.

Sol. (b)

103. Consider the following work materials:

1. Titanium

2. Mild steel

3. Stainless steel

4. Grey cast iron.

The correct sequence of these materials in terms of increasing order of difficulty in machining is

(a) 4, 2, 3, 1

(b) 4, 2, 1, 3

(c) 2, 4, 3, 1

(d) 2, 4, 1, 3.

Sol. (a)

104. The primary tool force used in calculating the total power consumption in machining is the

(a) radial force

(b) tangential force

(c) axial force

(d) frictional force.

Sol. (b)

105. In the grinding wheel of A 60 G 7 B 23, B stands for

(a) resinoid bond

(b) rubber bond

(c) shellac bond

(d) silicate bond.

Sol. (a)

106. Soft materials cannot be economically ground due to

(a) the high temperatures involved

(b) frequent wheel clogging

(c) rapid wheel wear

(d) low work piece stiffness.

Sol. (b)

107. The effects of setting a boring tool above centre height leads to a/an.

- (a) increase in the effective rake angle and a decrease in the effective clearance angle.
- (b) increase in both effective rake angle and effective clearance angle.
- (c) decrease in the effective rake angle and an increase in the effective clearance angle.
- (d) decrease in both effective rake angle and effective clearance angle.

Sol. (a)

108. In a milling operation two side milling cutters are mounted with a desired distance between them so that both sides of a work piece can be milled simultaneously.

This set up is called.

- (a) gang milling
- (b) straddle milling
- (c) string milling
- (d) side milling.

Sol. (a)

109. Match List I with List II and select the correct answering the codes given below the lists :

List I (Product)

List II (Process of manufacture)

- | | |
|--|----------------------------------|
| A. Automobile piston in aluminium alloy | 1. Pressure die-casting. |
| B. Engine crankshaft in spheroidal graphite iron | 2. Gravity die-casting. |
| C. Carburettor housing in aluminium alloy | 3. Sand casting. |
| D. Cast titanium blades | 4. Precision investment casting. |
| | 5. Shell moulding. |

Codes : A B C D

(a) 2 3 1 5

(c) 2 1 3 4

(b) 3 2 1 5

(d) 4 1 2 3

Sol. (a)

110. Addition of magnesium to cast iron increases its

- (a) hardness
- (b) ductility and strength in tension
- (c) corrosion resistance
- (d) creep strength.

Sol. (b)

111. Which one of the following materials will require the largest size of riser for the same size of casting ?

- (a) Aluminium
- (b) Cast iron
- (c) Steel
- (d) Copper.

Sol. (b)

112. Directional solidification in castings can be improved by using

- (a) chills and chaplets
- (b) chills and padding
- (c) chaplets and padding
- (d) chills, chaplets and padding.

Sol. (b)

113. In a mechanical shaper, the length of stroke is increased by

- (a) increasing the centre distance of bull gear and crank pin.
- (b) decreasing the centre distance of bull gear and crank pin.
- (c) increasing the length of the ram.
- (d) decreasing the length of the slot in the slotted lever.

Sol. (a)

114. While cutting helical gears on a non-differential gear hobber, the feed change gear ratio is

- (a) independent of index change gear ratio
- (b) dependent on speed change gear ratio
- (c) interrelated to index change gear ratio
- (d) independent of speed and index change gear ratio.

Sol. (c)

115. Consider the following characteristics :

1. Multiple operations can be performed.
2. Operator's fatigue is greatly reduced.
3. Ideally suited for batch production.
4. A break-down in one machine does not affect the flow of products.
5. Can accommodate modifications in design of components, within certain limits.

The characteristics which can be attributed to special purpose machines would include

- (a) 1, 3 and 4 (b) 1, 2 and 4 (c) 2, 3 and 5 (d) 1, 2 and 5.

Sol. (c)

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

<i>List I</i>					<i>List II</i>				
<i>(A function connected with NC m/c tool)</i>					<i>(Associated parameter)</i>				
A.	Interpolation				1.	Tape preparation.			
B.	Parity check				2.	Canned cycle.			
C.	Preparatory function				3.	Drilling.			
D.	Point to point control				4.	Contouring			
					5.	Turning.			
Codes :	A	B	C	D		A	B	C	D
(a)	4	1	2	3	(b)	4	1	2	5
(c)	5	1	3	2	(d)	1	4	3	2

Sol. (a)

117. Consider the following characteristics of production jobs:

1. Processing of parts frequently in small lots
2. Need to accommodate design changes of products.
3. Low rate of metal removal.
4. Need for holding close tolerances.

The characteristics which favour the choice of numerically controlled machines would include

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

Sol. (d)

118. In APT language, the cutter motion in incremental coordinate mode is addressed as

- (a) GO / TO /..... (b) GO/TO..... (c) GO DLTA/.... (d) GO FWD/...

Sol. (a)

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

<i>List I (Task)</i>					<i>List II (Recommendation)</i>				
A.	Three components in a straight line should worked in one loading				1.	Clamp with a floating pad.			
B.	Unloading of clamp element from jig is essential				2.	Quick action nut.			
C.	Clamping of rough surfaces				3.	Cam clamp.			
D.	Need for heavy clamping force				4.	Equalising clamp.			
					5.	Strap clamp.			
Codes :	A	B	C	D		A	B	C	D
(a)	5	2	3	4	(b)	4	2	1	5
(c)	1	4	2	3	(d)	4	1	5	3

Sol. (d)

120. If the diameter of the hole is subject to considerable variation, then for locating in jigs and fixtures, the pressure type of locator used is

(a) Conical locator

(b) Cylindrical locator

(c) Diamond pin locator

(d) Vee locator.

Sol. (a)

Engineering Services Examination
MECHANICAL ENGINEERING-1996
PAPER-I

1. 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.
2. You have to mark all your responses ONLY on the separate Answer Sheet provided. See directions in the Answer Sheet.
3. All items carry equal marks. Attempt all items. Your total marks will depend only on the number of correct responses marked by you in the Answer Sheet.

1. 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.

Sol. (c) Heat transfer takes place according to second law of thermodynamics as it tells about the direction and amount of heat flow that is possible between two reservoirs.

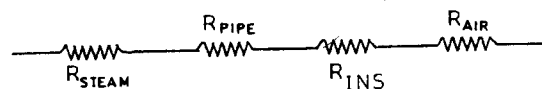
2. It is desired to increase the heat dissipation rate over the surface of an electronic device of spherical shape of 5 mm radius exposed to convection with $h = 10 \text{ W/m}^2\text{k}$ by encasing it in a spherical sheath of conductivity 0.04 W/mk. For maximum heat flow, the diameter of the sheath should be
 - (a) 18 mm
 - (b) 16 mm
 - (c) 12 mm
 - (d) 8 mm.

Sol. (a) The critical radius of insulation for ensuring maximum heat transfer by conduction = $\frac{k}{h} = \frac{0.04}{10} \text{ m}$
 = 4 mm

Radius of electronic device of spherical shape = 5 mm.

\therefore Radius of sheath over this device should be $5 + 4 = 9 \text{ mm}$ and diameter = 18 mm.

3. A pipe carrying saturated steam is covered with a layer of insulation and exposed to ambient air. The thermal resistances are as shown in the following figure.



Which one of the following statements is correct in this regard.

- (a) R_{steam} and R_{pipe} are negligible as compared to R_{ins} and R_{air}
- (b) R_{pipe} and R_{air} are negligible as compared to R_{ins} and R_{steam}
- (c) R_{steam} and R_{air} are negligible as compared to R_{pipe} and R_{ins}
- (d) No quantitative data is provided, therefore no comparison is possible.

Sol. (a) The resistance due to steam film and pipe material are negligible in comparison to resistance of insulation material and resistance due to air film.

4. Which one of the following statements is correct ?

Hydrodynamic entrance length for

- laminar flow is greater than that for turbulent flow.
- turbulent flow is greater than that for laminar flow.
- laminar flow is equal to that for turbulent flow.
- a given flow can be determined only if the Prandtl number is known.

Sol. (a) Hydrodynamic entrance length for laminar flow is greater than that for turbulent flow.

5. Match List I with List II and select the correct :

List I

- Reynolds Number
- Prandtl Number
- Nusselt Number
- Mach Number

Codes : A B C D

(a) 4 1 3 2

(c) 2 3 1 4

List II

- Film coefficient, pipe diameter, thermal conductivity
- Flow velocity, acoustic velocity
- Heat capacity, dynamic viscosity, thermal conductivity.
- Flow velocity, pipe diameter, kinematic viscosity.

A B C D

(b) 4 3 1 2

(d) 2 1 3 4

Sol. (b) The correct matching is A-4, B-3, C-1, D-2 ; because $Re = \frac{\rho V l}{\mu}$, $Pr = \frac{C_p \mu}{k}$, $Nu = \frac{hl}{k}$, $M = \frac{v}{v_a}$

6. Match List I with List II and select the correct answer

List I

- Window glass
- Gray surface
- Carbon dioxide
- Radiosity

Codes : A B C D

(a) 1 4 2 3

(c) 4 1 2 3

List II

- Emissivity independent of wavelength.
- Emission and absorption limited to certain bands of wavelength.
- Rate at which radiation leaves a surface.
- Transparency to short wave radiation.

A B C D

(b) 4 1 3 2

(d) 1 4 3 2

Sol. (a) The correct choice is (a), because for window glass, emissivity is independent of wavelength, gray surface has transparency to short wave length, for carbon dioxide the emission and absorption is limited to certain wave lengths, and radiosity is the rate at which radiation leaves a surface.

7. Match List I with List II and select the correct answer

List I

- Momentum transfer
- Mass transfer
- Heat transfer

Codes : A B C

(a) 2 3 1

(c) 3 2 1

List II

- Thermal diffusivity.
- Kinematic viscosity.
- Diffusion coefficient.

A B C

(b) 1 3 2

(d) 1 2 3

Sol. (a) The correct matching is

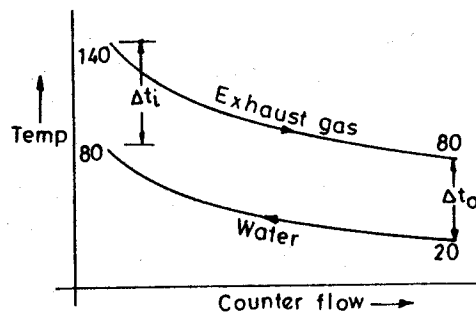
- | | |
|----------------------|---------------------------|
| A. Momentum transfer | 2. Kinematic viscosity. |
| B. Mass transfer. | 3. Diffusion coefficient. |
| C. Heat transfer | 1. Thermal diffusivity. |

8. A counterflow heat exchanger is used to heat water from 20°C to 80°C by using hot exhaust gas entering at 140°C and leaving at 80°C. The log mean temperature difference for the heat exchanger is

- (a) 80°C
(c) 110°C

- (b) 60°C
(d) not determinable as zero/zero is involved.

Sol. (d)



$$LMTD = \frac{\Delta t_o - \Delta t_i}{\log_e \Delta t_o / \Delta t_i} = \frac{(80 - 20) - (140 - 80)}{\log_e 60/60} = \frac{60 - 60}{\log_e 1} = \frac{0}{0}$$

Thus LMTD is not determinable as a zero/zero is involved.

9. A heat exchanger with heat transfer surface area A and overall heat transfer coefficient U handles two fluids of heat capacities C_1 and C_2 such that $C_1 > C_2$. The NTU of the heat exchanger is given by

- (a) AU/C_2 (b) $e^{-(AU/C_2)}$ (c) $e^{-(AU/C_1)}$ (d) AU/C_1

Sol. (a) NTU (number of transfer units) used in analysis of heat exchanger is specified as AU/C_2 .

10. Consider the following statements regarding condensation heat transfer :

1. For a single tube, horizontal position is preferred over vertical position for better heat transfer.
2. Heat transfer coefficient decreases if the vapour stream moves at high velocity.
3. Condensation of steam on an oily surface is dropwise.
4. Condensation of pure benzene vapour is always dropwise.

Of these statements

- (a) 1 and 2 are correct (b) 2 and 4 are correct.
(c) 1 and 3 are correct (d) 3 and 4 are correct.

Sol. (a) Statements 1 and 2 are correct and statements 3 and 4 are incorrect.

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

1. Fins are equally effective irrespective of whether they are on the hot side or cold side of the fluid.
2. The temperature along the fin is variable and hence the rate of heat transfer varies along the elements of the fin.
3. The fins may be made of materials that have a higher thermal conductivity than the material of the wall.
4. Fins must be arranged at right angles to the direction of flow of the working fluid.

Of these statements

- (a) 1 and 2 are correct (b) 2 and 4 are correct.
(c) 1 and 3 are correct (d) 2 and 3 are correct.

Sol. (b) Statement 1 is wrong because fins are effective on hot side of fluid for dissipating heat.

Statement 2 is correct.

Statement 3 is wrong because it is good enough to have same material for wall and fin.

Statement 4 is correct.

This right alternative is (b), i.e. statements 2 and 4 are correct.

12. Consider the following statements :

1. Under certain conditions, an increase in thickness of insulation may increase the heat loss from a heated pipe.
2. The heat loss from an insulated pipe reaches a maximum when the outside radius of insulation is equal to the ratio of thermal conductivity to the surface coefficient.
3. Small diameter tubes are invariably insulated.
4. Economic insulation is based on minimum heat loss from pipe.

Of these statements

- (a) 1 and 3 are correct (b) 2 and 4 are correct.
 (c) 1 and 2 are correct (d) 3 and 4 are correct.

Sol. (c) Statements at 1 and 2 are correct.

13. Addition of fin to the surface increases the heat transfer if $\sqrt{hA/KP}$ is

- (a) equal to one (b) greater than one
 (c) less than one (d) greater than one but less than two.

Sol. (c) Addition of fin to the surface increases the heat transfer if $\sqrt{hA/KP} \ll 1$.

14. Consider the development of laminar boundary layer for a moving non-reacting fluid in contact with a flat plate of length 'l' along the flow direction. The average value of heat transfer coefficient can be obtained by multiplying the local heat transfer coefficient at the trailing edge by the factor

- (a) 0.75 (b) 1.0 (c) 1.5 (d) 2.0.

Sol. (d)

15. In a vapour compression refrigeration system, a throttle valve is used in place of an expander because

- (a) it considerably reduces the system weight.
 (b) it improves the COP, as the condenser is small.
 (c) the positive work in isentropic expansion of liquid is very small.
 (d) it leads to significant cost reduction.

Sol. (c) In a vapour compression refrigeration system, expander is not used because the positive work in isentropic expansion of liquid is so small that it can't justify cost of expander. Thus a throttle valve is used in place of expander.

16. A cube at high temperature is immersed in a constant temperature bath. It loses heat from its top, bottom and side surfaces with heat transfer coefficient of h_1 , h_2 and h_3 respectively. The average heat transfer coefficient for the cube is

- (a) $h_1 + h_2 + h_3$ (b) $(h_1 h_2 h_3)^{1/3}$ (c) $\frac{1}{h_1} + \frac{1}{h_2} + \frac{1}{h_3}$ (d) none of the above.

Sol. (a) Losing of heat from top, bottom and side surfaces of cubes is equivalent to considering that resistances, to heat flow are in parallel. For parallel resistance, $\frac{1}{R_{av}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ or

$h_{av} = h_1 + h_2 + h_3$. Thus correct choice is (a).

17. Match items in List I with those in List II and III and select the correct answer.

- List I*
 A. Reversed Carnot engine
 B. Subcooling
 C. Superheating
 D. Constant enthalpy

- List II*
 1. Condenser
 2. Evaporator
 3. Vortex refrigerator
 4. Throttling
 5. Heat pump

- List III*
 6. Generator
 7. Increase in refrigerating effect.
 8. Highest COP.
 9. Adiabatic.
 10. Dry compression.

- Codes : A B C D
 (a) 3, 10 1, 7 2, 9 4, 6
 (c) 4, 10 3, 8 3, 10 1, 6

- A B C D
 (b) 5, 8 1, 7 2, 10 4, 9
 (d) 2, 7 5, 8 4, 6 1, 9

Sol. (b) Reversed Carnot engine is used for heat pump and it has highest COP. Thus for A, the correct choice from List II and List III is 5, 8. Sub cooling occurs in condenser and it increases refrigeration effect. Therefore for B, the correct choice from List II and III is 1, 7.

Superheating occurs in evaporator and it is involved in dry compression. Thus for Part C in List I, the correct choice from Lists II and III is 2, 10. Constant enthalpy process takes place during throttling and is basically adiabatic process. This D is matched with 4,9.

All the above choices are correctly shown in choice (b).

18. Consider the following statements :

In ammonia refrigeration systems, oil separator is provided because

1. Oil separation in evaporator would lead to reduction in heat transfer coefficient.
2. Oil accumulation in the evaporator causes choking of evaporator.
3. Oil is partially miscible in the refrigerant.
4. Oil causes choking of expansion device.

Of these statements

- | | |
|---------------------------|----------------------------|
| (a) 1 and 2 are correct | (b) 2 and 4 are correct |
| (c) 2,3 and 4 are correct | (d) 1,3 and 4 are correct. |

Sol. (b) Statements 2 and 4 are correct.

19. Consider the following statements :

Moisture should be removed from refrigerants to avoid

- | | |
|-------------------------------------|-------------------------------------|
| 1. compressor seal failure. | 2. freezing at the expansion valve. |
| 3. restriction to refrigerant flow. | 4. corrosion of steel parts. |

Of these statements

- | | |
|-----------------------------|----------------------------|
| (a) 1,2,3 and 4 are correct | (b) 1 and 2 are correct. |
| (c) 2,3 and 4 are correct | (d) 1,3 and 4 are correct. |

Sol. (a) All the statements about effect of moisture on refrigerant are correct and thus (a) is the right choice.

20. Consider the following statements :

1. Practically all common refrigerants have approximately the same COP and power requirement.
2. Ammonia mixes freely with lubricating oil and this helps lubrication of compressors.
3. Dielectric strength of refrigerants is an important property in hermetically sealed compressor units.
4. Leakage of ammonia can be detected by halide torch method.

Of these statements

- | | |
|---------------------------|--------------------------|
| (a) 1,2 and 4 are correct | (b) 2 and 4 are correct. |
| (c) 1,3 and 4 are correct | (d) 1 and 3 are correct. |

Sol. (d) Practically all refrigerants, except CO₂ have fairly same COP and power requirements. Thus statement (a) is correct.

Ammonia does not mix freely with lubricating oil. Therefore statement (b) is wrong.

Dielectric strength of refrigerants is an important property in hermetically sealed compressor units.

Leakage of ammonia is detected by its odour or sulphur candle with which ammonia forms white smoke like fumes.

Thus statements 1 and 4 are correct and choice (d) is the right choice.

21. The most commonly used method for the design of duct size is the

- | | |
|-------------------------------|---------------------------------|
| (a) velocity reduction method | (b) equal friction method. |
| (c) static regain method. | (d) dual or double duct method. |

Sol. (a) The most commonly used method for the design of duct size is the velocity reduction method.

22. The refrigerant used for absorption refrigerators working heat from solar collectors is a mixture of water and

- (a) carbon dioxide (b) sulphur dioxide (c) lithium bromide (d) freon 12.

Sol. (c) The refrigerant used for absorption refrigerators working on heat from solar collectors is a mixture of water and lithium bromide.

23. During the adiabatic cooling of moist air

- (a) DBT remains constant. (b) specific humidity remains constant.
(c) relative humidity remains constant. (d) WBT remains constant.

Sol. (d) During the adiabatic cooling of moist air, wet bulb temperature remains constant.

24. When a stream of moist air is passed over a cold and dry cooling coil such that no condensation takes place, then the air stream will get cooled along the line of

- (a) constant wet bulb temperature (b) constant dew point temperature
(c) constant relative humidity (d) constant enthalpy.

Sol. (b) When a stream of moist air is passed over a cold and dry cooling coil such that no condensation takes place, then air stream is cooled along constant dew point temperature.

25. For large tonnage (more than 200 tons) air-conditioning applications, which one of the following types of compressors is recommended ?

- (a) Reciprocating (b) Rotating (c) Centrifugal (d) Screw.

Sol. (d) For large tonnage air conditioning applications, specially built centrifugal compressors are used.

26. In a cooling tower, "approach" is the temperature difference between the

- (a) hot inlet water and cold outlet water. (b) hot inlet water and WBT.
(c) cold outlet water and WBT (d) DBT and WBT.

Sol. (b) Approach in cooling towers refers to temperature difference between the hot inlet water and wet bulb temperature.

27. When the discharge pressure is too high in a refrigeration system, high pressure control is installed to

- (a) stop the cooling fan. (b) stop the water circulating pump.
(c) regulate the flow of cooling water. (d) stop the compressor.

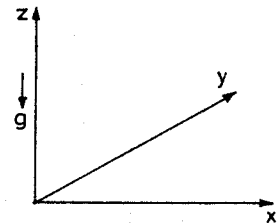
Sol. (c) When the discharge pressure is too high in refrigeration system, high pressure control is installed to regulate the flow of cooling water.

28. If z is vertically upwards, ρ is the density and g gravitational acceleration (see figure) then the pressure $\partial p / \partial z$ in a fluid at rest due to gravity is given by

- (a) $\rho g z^2 / 2$ (b) $-\rho g$
(c) $-\rho g z$ (d) $\rho g / z$

Sol. (b) Pressure at any point at depth z due to gravitational acceleration is $p = \rho g z$.

Since z is vertically upwards, $\therefore \frac{\partial p}{\partial z} = -\rho g$



29. A rectangular water tank, full to the brim, has its length, breadth and height in the ratio of 2:1:2. The ratio of hydrostatic forces at the bottom to that at any larger vertical surface is

- (a) 1/2 (b) 1 (c) 2 (d) 4.

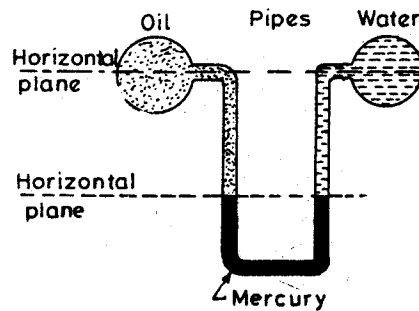
Sol. (a) Hydrostatic force at bottom $= \rho g A \bar{z} = \rho g (2x \times 1x) \times \frac{2x}{2}$ (length = $2x$; breadth = $1x$; height = $2x$)
 $= 2fgx^3$

Hydrostatic force at larger vertical surface $= \rho g (2x \times 2x) \times 2x/2 = 4\rho gx^3$

\therefore Ratio of above two forces $= 1/2$

30. The manometer shown in the given figure connects two pipes, carrying oil and water respectively. From the figure one

- can conclude that the pressures in the pipes are equal.
- can conclude that the pressure in the oil pipe is higher.
- can conclude that the pressure in the water pipe is higher.
- cannot compare the pressure in the two pipes for want of sufficient data.



Sol. (b) Oil has density lower than that of water. Thus static head of oil of same height will be lower. Since mercury is at same horizontal plane in both limbs, the lower static head of oil can balance higher static head of water when oil pressure in pipe is higher.

31. Consider the following statements:

The metacentric height of a floating body depends

- directly on the shape of its water-line area.
- on the volume of liquid displaced by the body.
- on the distance between the metacentre and the centre of gravity.
- on the second moment of water-line area.

Of these statements

- 1 and 2 are correct
- 2 and 3 are correct.
- 3 and 4 are correct
- 1 and 4 are correct.

Sol. (b) The metacentric height of a floating body depends on (2) and (3), i.e. volume of liquid displaced by the body and on the distance between the metacentre and the centre of gravity.

32. Which one of the following statements is true to two-dimensional flow of ideal fluids ?

- Potential function exists if stream function exists.
- Stream function may or may not exist.
- Both potential function and stream function must exist for every flow.
- Stream function will exist but potential function may or may not exist.

Sol. (c) For two-dimensional flow of ideal fluids, both potential function and stream function must exist.

33. The curl of a given velocity field ($\nabla \times \vec{V}$) indicates the rate of

- increase or decrease of flow at a point.
- twisting of the lines of flow.
- deformation
- translation.

Sol. (a) The curl of a given velocity field ($\nabla \times \vec{V}$) indicates the rate of increase or decrease of a flow at a point.

34. Match List I (fluid properties) with List II (related terms) and select the correct answer.

List I

- Capillarity
- Vapour pressure
- Viscosity
- Specific gravity

List II

- Cavitation.
- Density of water.
- Shear forces.
- Surface tension.

Codes : A B C D

(a) 1 4 2 3

(c) 4 1 2 3

A B C D

(b) 1 4 3 2

(d) 4 1 3 2

Sol. (d) It may be noted that capillarity is related with surface tension, vapour pressure with cavitation, viscosity with shear forces, and specific gravity with density of water.

35. The general form of expression for the continuity equation in a cartesian coordinate system for incompressible or compressible flow is given by

- (a) $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$ (b) $\frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} = 0$
 (c) $\frac{\partial \rho}{\partial t} + \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} = 0$ (d) $\frac{\partial \rho}{\partial t} + \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} = 1$.

Sol. (a) The general form of expression for the continuity equation in a cartesian coordinate system for incompressible or compressible flow is given by $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$.

36. In a two-dimensional flow in x-y plane, if $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$, then the fluid element will undergo

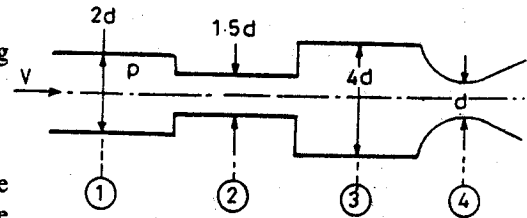
- (a) translation only (b) translation and rotation.
 (c) translation and deformation (d) rotation and deformation.

Sol. (d) In a two-dimensional flow in x-y plane, if $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$, then the fluid element will undergo rotation and deformation.

37. Water flow through a pipeline having four different diameters at 4 stations is shown in the given figure

The correct sequence of station numbers in the decreasing order of pressures is

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



Sol. (d) It must be remembered that velocity and pressure head behave in reverse fashion. Thus velocity will be maximum for least area and pressure will be minimum. ∴ Correct sequence of station numbers in the decreasing order of pressure is in order of maximum to minimum area, i.e. 3, 1, 2, 4.

38. During the measurement of viscosity of air flowing through a pipe, we use the relation

$$\rho = \frac{\pi d^4}{128Q} \cdot \left(-\frac{dp}{dx} \right)$$

under the condition that in the measuring section.

- (a) there is a viscous zone near the wall and an inviscid core persists at the centre.
 (b) the entire cross-section is viscous.
 (c) the flow can be assumed as potential flow. (d) the flow is irrotational.

Sol. (a) The required relation assumes that there is a viscous zone near the wall and an inviscid cone persists at the centre.

39. If energy grade and hydraulic grade lines are drawn for flow through an inclined pipeline the following 4 quantities can be directly observed:

1. Static head 2. Friction head. 3. Datum head 4. Velocity head.

Starting from the arbitrary datum line, the above types of heads will be in the sequence

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

Sol. (d) Starting from the arbitrary datum line, the heads in sequence will be 3-datum head, 1-static head, 4-velocity head, and 2- friction head.

40. If a calibration chart is prepared for a hot-wire anemometer for measuring the mean velocities, the highest level of accuracy can be
- equal to accuracy of a Pitot tube.
 - equal to accuracy of a rotameter.
 - equal to accuracy of a venturimeter.
 - more than that of all the three instruments mentioned above.

Sol. (d) Hot wire anemometer is more accurate than pitot tube, rotameter, or venturimeter.

41. At the point of boundary layer separation
- shear stress is maximum.
 - shear stress is zero
 - velocity is negative.
 - density variation is maximum.

Sol. (a) At the point of boundary layer separation the velocity gradient is steeper and thus shear stress being function of velocity gradient attains very high value.

42. All experiments thus far indicate that there can be a laminar flow in a pipe if the Reynolds number is below:
- 2300
 - 4000
 - 20000
 - 40000.

Sol. (a) All experiments thus far indicate that there can be only laminar flow in a pipe if the Reynolds number is below 2300.

43. If $\frac{\partial u'}{\partial x} + \frac{\partial v'}{\partial y} = 0$ for a turbulent flow then it signifies that
- bulk momentum transport is conserved.
 - $u'v'$ is non-zero and positive.
 - turbulence is anisotropic.
 - none of the above is true.

Sol. (a) If $\frac{\partial u'}{\partial x} + \frac{\partial v'}{\partial y} = 0$ for a turbulent flow then it signifies that the bulk momentum transport is conserved.

44. The predominant forces acting on an element of fluid in the boundary layer over a flat plate placed in a uniform stream include
- inertia and pressure forces.
 - viscous and pressure forces.
 - viscous and body forces.
 - viscous and inertia forces.

Sol. (b) The predominant forces acting on an element of fluid in the boundary layer over a flat plate placed in a uniform stream include viscous and pressure forces.

45. Which one of the following velocity distributions of u/u_∞ satisfies the boundary conditions for laminar flow on a flat plate? (Here u_∞ is the free stream velocity, u is velocity at any normal distance y from the flat plate, $\eta = y/\delta$ and δ is boundary layer thickness)
- $\eta - \eta^2$
 - $1.5\eta - 0.5\eta^3$
 - $3\eta - \eta^2$
 - $\cos(\pi\eta/2)$

Sol. (b) The relation $\frac{u}{u_\infty} = \frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$ satisfies boundary condition for laminar flow on a flat plate.

46. The turbulent boundary-layer thickness varies as
- $x^{4/5}$
 - $x^{1/2}$
 - $x^{1/5}$
 - $x^{1/7}$

Sol. (a) The turbulent boundary-layer thickness varies as $x^{4/5}$.

47. During the flow over a circular cylinder, the drag coefficient drops significantly at a critical Reynolds number of 2×10^5 . This is due to
- excessive momentum loss in the boundary layer.
 - separation point travelling upstream.
 - reduction in skin-friction drag.
 - the delay in separation due to transition to turbulence.

Sol. (a) During the flow over a circular cylinder, the drag coefficient drops significantly at critical Reynolds number due to slowing down of more and more fluid particles (excessive momentum loss) and flow becoming unstable.

48. Match List I with List II and select the correct answer

<i>List I (Predominant force)</i>					<i>List II (Dimensionless numbers)</i>				
A.	Compressibility force				1.	Euler number.			
B.	Gravity force				2.	Prandtl number			
C.	Surface tension force				3.	Mach number.			
D.	Viscous force				4.	Reynolds number.			
					5.	Weber number.			
Codes :	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	3	2	5	4
(c)	3	1	4	5	(d)	2	3	5	1

Sol. (b) When compressibility force is predominant, mach number is used; when gravity force predominates, Froude number is adopted. Similarly for surface tension force and viscous force, Weber number and Reynolds number are considered.

49. Kinematic similarity between model and prototype is the similarity of
 (a) shape (b) discharge (c) stream line pattern (d) forces.

Sol. (c) Kinematic similarity between a model and its prototype is said to exist if the flow patterns are in geometric similarity.

50. The specific speed of a turbine is defined as the speed of a member of the same homologous series of such a size that it

- (a) delivers unit discharge at unit head.
- (b) delivers unit discharge at unit power.
- (c) delivers unit power at unit discharge.
- (d) produces unit power under a unit head.

Sol. (d) The specific speed of a turbine is defined as the speed of member of the same homologous series of such a size that it produces unit power under a unit head.

51. Match List I with List II and select the correct answer

<i>List I</i>				<i>List II</i>			
A.	Pelton wheel (single jet)			1.	Medium discharge, low head.		
B.	Francis Turbine			2.	High discharge, low head.		
C.	Kaplan Turbine			3.	Medium discharge, medium head		
				4.	Low discharge, high head		
Codes :	A	B	C		A	B	C
(a)	1	2	3	(b)	1	3	4
(c)	4	1	3	(d)	4	3	2

Sol. (d) The correct matching is

- A. Pelton wheel 4. Low discharge, high head.
- B. Francis turbine 3. Medium discharge, medium speed.
- C. Kaplan turbine 2. High discharge, low head.

52. Consider the following statements:

If pump NPSH requirements are **not** satisfied, then

- 1. it will not develop sufficient head to raise water.
- 2. its efficiency will be low.

3. it will deliver very low discharge.
4. it will be cavitaded.

Of these statements

- (a) 1,2 and 3 are correct. (b) 2,3, and 4 are correct.
(c) 1 and 4 are correct (d) 1,2,3 and 4 are correct.

Sol. (d) All the four statements will apply if pump NPSH requirement is not satisfied.

53. In reaction turbines, the draft tube is used

- (a) for the safety of the turbine.
(b) to convert the kinetic energy of flow by a gradual expansion of the flow cross-section.
(c) to destroy the undesirable eddies.
(d) for none of the above purposes.

Sol. (b) In reaction turbine, the draft tube is used to convert the kinetic energy of flow by a gradual expansion of the flow cross-section.

Directions: The following fifteen items consist of two statements, one labelled the 'Assertion A' and the other labelled the 'Reason R'. You are to examine these two statements carefully and decide if the Assertion A and the Reason R are individually true and if so, whether the Reason is a correct explanation of the Assertion. Select your answers to these items using the codes given below and mark your answer sheet accordingly.

- (a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not a correct explanation of A.
(c) A is true but R is false. (d) A is false but R is true.

54. Assertion (A) : Ratio of specific heats C_p/C_v decreases with increases in temperature.

Reason (R) : With increase in temperature, C_p decreases at a higher rate than C_v .

Sol. (c) A is correct but R is false.

55. Assertion (A) : In SI engines, as the engine speed increases, spark is required to be advanced.

Reason (R) : As the engine speed increases, flame velocity increases.

Sol. (c) A is true but R is false.

56. Assertion (A) : A very high compression ratio is favoured for a CI engine, in order to attain high mechanical efficiency without knocking.

Reason (R) : The delay period in CI combustion affects rate of pressure rise and hence knocking.

Sol. (d) A is false but R is true.

57. Assertion (A) : The efficiency of a boiler is more if it is provided with mechanical draught rather than with natural draught.

Reason (R) : The exhaust gases can be cooled to the lowest possible temperature if mechanical draught is provided.

Sol. (a) Both A and R are true and R is correct explanation for A.

58. Assertion (A) : For pressure ratio greater than the critical pressure ratio, a convergent - divergent nozzle is required.

Reason (R) : Divergent portion increases the flow area which increases the mass flow rate.

Sol. (c) A is correct but R is wrong.

59. Assertion (A) : The speed of governed turbine is constant irrespective of load.

Reason (R) : In governing, the steam supply is regulated to maintain the speed.

Sol. (a) Both A and R are true and R provides correct explanation for A.

60. Assertion (A) : In the case of reaction turbines for power plant applications, a large number of stages is common in practice.

Reason (R) : A pressure drop takes place in the moving blade in a reaction turbine unlike an impulse turbine, where pressure remains constant across the moving blade.

Sol. (b) Both A and R are true, but R is not a correct explanation of A.

61. Assertion (A) : In a gas turbine, reheating is preferred over regeneration to yield a higher thermal efficiency.

Reason (R) : The thermal efficiency given by the ratio of the difference of work done by turbine (W_t) and work required by compressor (W_c) to heat added (Q_A) is improved by increasing the W_t keeping W_c and Q_A constant in reheating, whereas in regeneration Q_A is reduced keeping W_t and W_c constant.

Sol. (d) A is false but R is true.

62. Assertion (A) : A slab of finite thickness heated on one side and held horizontal will lose more heat per unit time to the cooler air if the hot surface faces upwards when compared with the case where the hot surface faces downwards.

Reason (R) : When the hot surface faces upwards, convection takes place easily whereas when the hot surface faces downwards, heat transfer is mainly by conduction through air.

Sol. (a) Both A and R are true, and R is correct explanation for A.

63. Assertion (A) : The nose of aeroplane is painted black.

Reason (R) : Black body absorbs maximum heat which is generated by aerodynamic heating when the plane is flying.

Sol. (a) Both A and R are true, and R is correct explanation for A.

64. Assertion (A) : In an air-conditioned room, the reflective coating should be on the inside of the window.

Reason (R) : Window pane glass is transparent to solar radiation.

Sol. (d) A is false but R is true.

65. Assertion (A) : No solid connection exists between the driving shaft and the driven shaft.

Reason (R) : Energy transfer is by the change in moment of momentum.

Sol. (b) Both A and R are true but R is not correct explanation of A.

66. Assertion (A) : In a fluid, the rate of deformation is far more important than the total deformation itself.

Reason (R) : A fluid continues to deform so long as the external forces are applied.

Sol. (a) Both A and R correct and R is correct explanation for A.

67. Assertion (A) : U-tube manometer connected to a venturimeter fitted in a pipeline can measure the velocity through the pipe.

Reason (R) : U-tube manometer directly measures dynamic and static heads.

Sol. (b) Both A and R are correct, but R is not correct explanation for A.

68. Assertion (A) : For a fully developed viscous flow through a pipe the 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.

Sol. (b) Both A and R are correct, but R is not correct explanation to A.

69. Match List I with List II and select the correct answer

List I

- A. Work done in a polytropic process.
 B. Work done in a steady flow process.
 C. Heat transfer in a reversible adiabatic process
 D. Work done in an isentropic process

List II

1. $-\int v dp$
 2. zero
 3. $\frac{p_1 V_1 - p_2 V_2}{\gamma - 1}$
 4. $\frac{p_1 V_1 - p_2 V_2}{n - 1}$

Codes : A B C D

(a) 4 1 3 2

(c) 4 1 2 3

A B C D

(b) 1 4 2 3

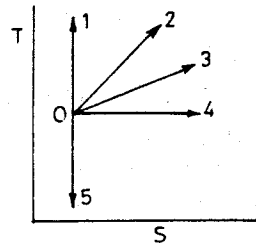
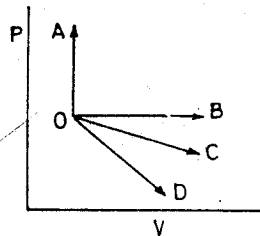
(d) 1 2 3 4

Sol. (c) The correct matching is provided by choice (c) i.e. A-4, B-1, C-2, D-3.

70. Match the curves in Diagram I with the curves in Diagram II and select the correct answer.

Diagram I (Process on p - V plane)

Diagram II (Process on T - S plane).



Codes : A B C D

(a) 3 2 4 5

(c) 2 3 4 1

A B C D

(b) 2 3 4 5

(d) 1 4 2 3

Sol. (b) The correct matching is provided by choice (b). i.e. A-2 ($n = \alpha$, $V = c$), B-3 ($n = 0$, $p = c$), C-4 ($n = 1$, $T = c$), D-5 ($n = \gamma$, $S = c$)

71. The heat transfer, Q , the work done W and the change in internal energy U are all zero in the case of

- (a) a rigid vessel containing steam at 150°C left in the atmosphere which is at 25°C
 (b) 1 kg of gas contained in an insulated cylinder expanding as the piston moves slowly outwards.
 (c) a rigid vessel containing ammonia gas connected through a valve to an evacuated rigid vessel, the vessel, the valve and the connecting pipes being well insulated and the valve being opened and after a time, conditions through the two vessels becoming uniform.
 (d) 1 kg of air flowing adiabatically from the atmosphere into a previously evacuated bottle.

Sol. (c) In example of (c), heat transfer, work done, and change in internal energy are all zero.

72. 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.

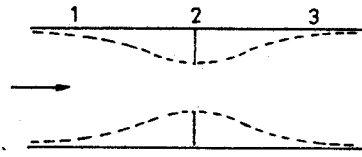
Sol. (d) Statement at (d) is correct definition of zeroth law of thermodynamics.

73. Which one of the following statements applicable to a perfect gas will also be true for an irreversible process ? (Symbols have the usual meanings).

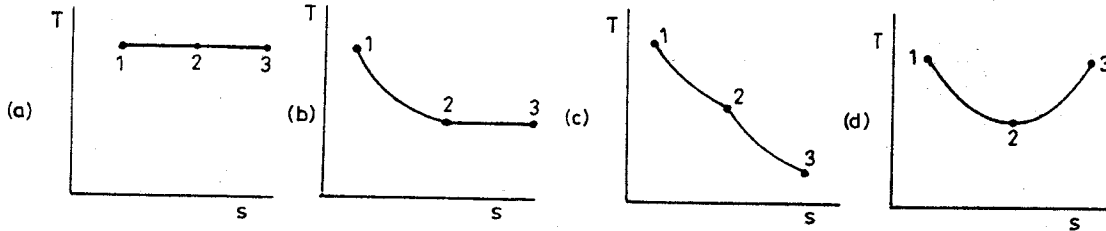
- (a) $dQ = du + pdV$ (b) $dQ = Tds$ (c) $Tds = du + pdV$ (d) None of the above.

Sol. (d) The relations in (a) to (c) are applicable for servrisible processes and none is applicable for irreversible process.

74. The throttling process undergone by a gas across an orifice is shown by its states in the following figure:

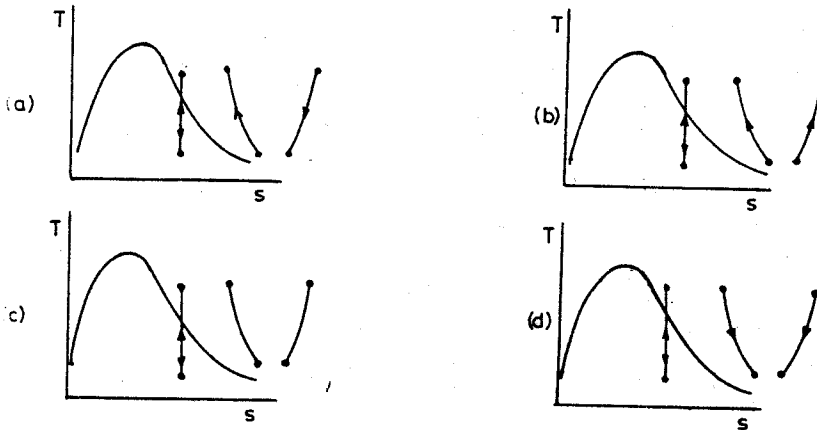


It can be represented on the T-s diagram as



Sol. (c) The throttling process takes places with enthalpy remaining constant. This process on T-S diagram is represented by a line starting diagonally from top to bottom. Thus figure(c)is the correct choice.

75. Which one of the following temperature entropy diagrams of steam shows the reversible and irreversible processes correctly?



Sol. (c) In reversible process entropy change is zero and in four figures it is represented by straight vertical line. However, in irreversible process, entropy increases in all processes (expansion as well as compression). This is true for alternative at (c).

76. Consider the following statements:

1. Availability is generally conserved.
2. Availability can either be negative or positive.
3. Availability is the maximum theoretical work obtainable.
4. Availability can be destroyed in irreversibilities.

Of these statements

- (a) 3 and 4 are correct (b) 1 and 2 are correct.
 (c) 1 and 3 are correct (d) 2 and 4 are correct.

Sol. (a) Availability is the maximum theoretical work obtainable and it can be destroyed in irreversibilities.

77. For a given volume of dry saturated steam, Clapeyron's equation is given by

$$(a) (V_2 - V_1) \frac{dT_s}{dP} \times \frac{T_s}{h_g - h_f} \quad (b) V_g - V_f = \frac{dT_s}{dP} \times \frac{h_g - h_f}{T_s}$$

$$(c) V_g - V_f = \frac{dP}{dT_s} \times \frac{h_g - h_f}{T_s} \quad (d) V_g - V_f = \frac{dP}{dT_s} \times \frac{T_s}{h_g - h_f}$$

Sol. (b) The Clapeyron's equation for a given volume of dry saturated steam is

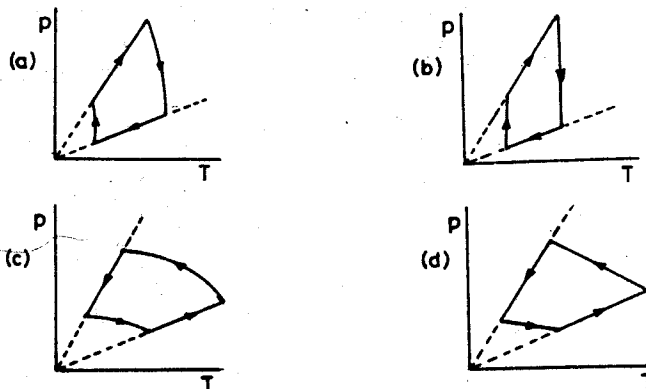
$$V_g - V_f = \frac{dT_s}{dQ} \times \frac{h_g - h_f}{T_s}$$

78. The Joule-Thomson coefficient is the

- (a) $\left(\frac{\partial T}{\partial p}\right)_h$ of pressure-temp curve of real gases
 (b) $\left(\frac{\partial T}{\partial s}\right)$ of temp.-entropy curve of real gases
 (c) $\left(\frac{\partial h}{\partial s}\right)_T$ of enthalpy-entropy curve of real gases
 (d) $\left(\frac{\partial V}{\partial T}\right)$ of pressure-volume curve of real gases.

Sol. (a) The slope of the isenthalpic curve at any point is known as Joule-Thomson coefficient and is expressed as $\mu = \left[\frac{\partial T}{\partial p}\right]_h$

79. Which one of the following p-T diagrams illustrates the Otto cycle of an ideal gas ?



Sol. (a) Figure (a) represents also cycle on P-T plane.

80. Consider the following statements regarding n-cetane :

1. It is a standard fuel used for knock rating of diesel engines.
2. Its chemical name is n-hexadecane.
3. It is a saturated hydrocarbon of paraffin series.
4. It has long carbon chain structure.

Of the above statements

- (a) 1, 3 and 4 are correct
 (b) 1, 2 and 3 are correct
 (c) 1, 2 and 4 are correct
 (d) 2, 3 and 4 are correct.

81. List I gives the different terms related to combustion while List II gives the outcome of the events that follow. Match List I with List II and select the correct answer.

<i>List I</i>				<i>List II</i>					
A.	Association			1.	Pseudo shock				
B.	Dissociation			2.	Knock				
C.	Flame front			3.	Endothermic				
D.	Abnormal combustion			4.	Exothermic.				
Codes :	A	B	C	D	A	B	C	D	
(a)	3	4	1	2	(b)	4	3	1	2
(c)	3	4	2	1	(d)	4	3	2	1

Sol. (d) The correct matching is provided by A-4, B-3, C-2, D-1.

82. Which one of the following engines will have heavier flywheel than the remaining ones ?

- 40 H.P. four-stroke petrol engine running at 1500 rpm.
- 40 H.P. two-stroke petrol engine running at 1500 rpm.
- 40 H.P. two-stroke diesel engine running at 750 rpm.
- 40 H.P. four-stroke diesel engine running at 750 rpm.

Sol. (d) The four stroke engine running at lower speed needs heavier fly wheel.

83. Consider the following statements:

Knock in the SI engine can be reduced by

- supercharging
- retarding the spark.
- using a fuel of long straight chain structure.
- increasing the engine speed.

Of these statement

- | | |
|---------------------------|--------------------------|
| (a) 1 and 2 are correct | (b) 2 and 3 are correct. |
| (c) 1,3 and 4 are correct | (d) 2 and 4 are correct. |

Sol. (d) Knock in SI engine can be reduced by retarding spark and increasing the engine speed.

84. Consider the following statements:

The injector nozzle of a CI engine is required to inject fuel at a sufficiently high pressure in order to

- be able to inject fuel in a chamber of high pressure at the end of the compression stroke.
- inject-fuel at high velocity to facilitate atomisation.
- ensure that penetration is not high.

Of the above statements

- | | |
|-------------------------|----------------------------|
| (a) 1 and 2 are correct | (b) 1 and 3 are correct. |
| (c) 2 and 3 are correct | (d) 1,2 and 3 are correct. |

Sol. (a) The statements 1 and 2 are correct.

85. Match List I with List II and select the correct answer

<i>List I (SI engine operating mode)</i>				<i>List II (Desired air-fuel ratio)</i>					
A.	Idling			1.	13.0				
B.	Cold starting			2.	4.0.				
C.	Cruising			3.	16.0				
D.	Full throttle			4.	9.0				
Codes :	A	B	C	D	A	B	C	D	
(a)	4	2	3	1	(b)	2	4	1	3
(c)	4	2	1	3	(d)	2	4	3	1

Sol. (a) Cold starting requires maximum fuel, idling requires little less fuel, full throttle requires still less fuel and idling requires minimum fuel. Thus the correct matching is A-4, B-2, C-3, D-1.

- 86.** Compensating jet in a carburettor supplies almost constant amount of petrol at all speeds because
- the jet area is automatically varied depending on the suction.
 - the flow from the main jet is diverted to the compensating jet with increase in speed.
 - the diameter of the jet is constant and the discharge coefficient is invariant.
 - the flow is produced due to the static head in the float chamber.

Sol. (b) Statement at (b) is correct.

87. In the context of performance evaluation of I.C. Engine, match List I with List II and select the correct answer.

<i>List I (Parameter)</i>				<i>List II (Equipment for measurement)</i>					
A.	Brake power (B.H.P.)			1.	Bomb calorimeter.				
B.	Engine speed			2.	Electrical tachometer.				
C.	Calorific value of fuel			3.	Hydraulic dynamometer.				
D.	Exhaust emissions			4.	Flame ionisation detector.				
Codes :	A	B	C	D	A	B	C	D	
(a)	3	1	2	4	(b)	4	2	1	3
(c)	3	2	1	4	(d)	2	3	4	1

Sol. (c) The correct matching is A-3, B-2, C-1, D-4.

88. Consider the following statements:

In open cycle turbo-jet engines used in military aircraft, reheating the exhaust gas from the turbine by burning more fuel is used to increase.

- thrust.
- the efficiency of engine.
- the range of aircraft.

Of these statements

- 1 and 3 are correct
- 2 and 3 are correct
- 1 and 2 are correct.
- 1, 2 and 3 are correct.

Sol. (b) The statements 1 and 2 are correct.

89. In a turbojet engine, subsequent to heat addition to compressed air, to get the power output, the working substance is expanded in

- turbine blades, which is essentially an isentropic process.
- turbine blades, which is a polytropic process.
- exit nozzle, which is essentially an isentropic process.
- exit nozzle, which is a constant volume process.

Sol. (a) The statement at (a) is correct.

90. Consider the following statements relating to rocket engines:

- The combustion chamber in a rocket engine is directly analogous to the reservoir of a supersonic wind tunnel.
- Stagnation conditions exist at the combustion chamber.
- The exit velocities of exhaust gases are much higher than those in jet engines.
- Efficiency of rocket engines is higher than that of jet engines.

Of these statements

- 1, 3 and 4 are correct
- 2, 3 and 4 are correct.
- 1, 2 and 3 are correct
- 1, 2 and 4 are correct.

Sol. (c) The statements 1, 2 and 3 are correct.

91. Only rocket engines can be propelled to 'SPACE' because
 (a) they can generate very high thrust. (b) they have high propulsion efficiency.
 (c) these engines can work on several fuels. (d) they are not air-breathing engines.

Sol. (d) Rocket engines can be propelled to space because they are not air breathing engines

92. Items given in List I and List II pertain to gas analysis.

Match List I with List II and select the correct answer.

List I

- A. CO₂
 B. Orsat apparatus
 C. CO
 D. O₂

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

List II

1. Alkaline pyrogallol.
 2. KOH solution.
 3. Wet analysis.
 4. Ammoniacal cuprous chloride.
 5. Dry analysis.

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

Sol. (d) The correct matching is A-2, B-5, C-4, D-1.

93. Which of the following factors are responsible formation of NO_x in spark ignition engine combustion :
 1. Incomplete combustion
 2. High temperature.
 3. Availability of oxygen.

Select the correct answer.

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

Sol. (a) NO_x is formed due to incomplete combustion and at high temperature.

94. Consider the following statements:

1. Gas cooled thermal reactors use CO₂ or helium as coolant and require no separate moderator.
 2. Fast reactors use heavy water as moderator and coolant.
 3. Liquid metal fast breeder reactors use molten sodium as coolant.
 4. In Candu type reactors heavy water is used as moderator.

Of these statements

- (a) 1 and 3 are correct (b) 2 and 4 are correct.
 (c) 3 and 4 are correct (d) 1 and 2 are correct.

Sol. (c) Statements 3 and 4 are correct.

95. Match List I with List II and select the correct answer.

List I

- A. Plutonium-239
 B. Thorium-233
 C. Cadmium
 D. Graphite

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

List II

1. Fissile material.
 2. Fissionable material.
 3. Moderator
 4. Poison.

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

Sol. (c) The correct matching is A-1, B-2, C-4, D-3.

96. In forced circulation boilers, about 90% of water is recirculated without evaporation. The circulation ratio is

- (a) 0.1 (b) 0.9 (c) 9 (d) 10.

Sol. (b) Circulation ratio is 0.9.

97. Given that,

h is draught in mm of water, H is chimney height in metres,
 T_1 is atmospheric temperature in K,

the maximum discharge of gases through a chimney is given by

(a) $h=176.5T_1/H$ (b) $h = H/176.5T_1$ (c) $h=1.765H/T_1$ (d) $h = 176.5H/T_1$.

Sol. (c) $h = 1.765 H/T$.

98. When solid fuels are burned, the nitrogen content of the flue gas by volume is about

(a) 60% (b) 70% (c) 80% (d) 90%.

Sol. (b) When solid fuels are burnt, the nitrogen content of flue gas by volume is about 70%.

99. The excess air required for combustion of pulverised coal is of the order of

(a) 100 to 150 % (b) 30 to 60%. (c) 15 to 40% (d) 5 to 10%.

Sol. (d) The excess air required for combustion of pulverised coal is of the order of 5 to 10%.

100. Ratio of actual indicated work to hypothetical indicated work in a steam engine is the

(a) indicated thermal efficiency (b) friction factor.
 (c) mechanical efficiency (d) diagram factor.

Sol. (d) Ratio of actual indicated work to hypothetical indicated work in a steam engine is the diagram factor.

101. Consider the following:

1. Increasing evaporation rate using convection heat transfer from hot gases.
2. Increasing evaporation rate using radiation.
3. Protecting the refractory walls of the furnace.
4. Increasing water circulation rate.

The main reasons for providing water wall enclosures in high pressure boiler furnaces would include

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

Sol. (c) Statements 1 and 2 are correct.

102. Running speeds of steam turbine can be brought down to practical limits by which of the following method(s) ?

1. By using heavy flywheel.
2. By using a quick response governor.
3. By compounding
4. By reducing fuel feed to the furnace.

(a) 3 alone (b) 1,2,3 and 4 (c) 1,2 and 4 (d) 2 and 3.

Sol. (d) Statements 2 and 3 are correct.

103. Consider the following statements:

Expansion joints in steam pipelines are installed to

1. allow for future expansion of plant.
2. take stresses away from flanges and fittings.
3. permit expansion of pipes due to temperature rise.

Of these statements

(a) 1,2 and 3 are correct (b) 1 and 2 are correct.
 (c) 2 and 3 are correct (d) 1 and 3 are correct.

Sol. (c) Expansion joints in steel pipe lines are installed to take stresses away from flanges and fittings and also to permit expansion of pipes due to temperature rise.

104. In a surface condenser used in a steam power station, undercooling of condensate is undesirable as this would

- (a) not absorb the gases in steam.
- (b) reduce efficiency of the plant.
- (c) increase the cooling water requirements.
- (d) increase thermal stresses in the condenser.

- Sol. (c)** In a surface condenser used in a steam power station, undercooling of a condensate is undesirable as this would increase the cooling water requirements.
- 105.** Of all the power plants, hydel is more disadvantageous when one compares the
- (a) nearness to load centre
 - (b) cost of energy resource
 - (c) technical skill required.
 - (d) economics that determine the choice of plant.
- Sol. (a)** Of all the power plants, hydel is more disadvantageous when one compares the nearness to load centre.
- 106.** In thermal power plants, the deaerator is used mainly to
- (a) remove air from condenser.
 - (b) increase freewater temperature.
 - (c) reduce steam pressure.
 - (d) remove dissolved gases from feedwater.
- Sol. (d)** In thermal power plants, the deaerator is used mainly to remove dissolved gases from feedwater.
- 107.** For a multistage compressor, the polytropic efficiency is
- (a) the efficiency of all stages combined together.
 - (b) the efficiency of one stage.
 - (c) constant throughout for all the stages.
 - (d) a direct consequence of the pressure ratio.
- Sol. (a)** For multistage compressor, the polytropic efficiency is the efficiency of all stages combined together.
- 108.** Which one of the following is the effect of blade shape on performance of a centrifugal compressor ?
- (a) Backward curved blade has poor efficiency.
 - (b) Forward curved blade has higher efficiency.
 - (c) Backward curved blades lead to stable performance.
 - (d) Forward curved blades produce lower pressure ratio
- Sol. (c)** In centrifugal compressor, backward curved blades lead to stable performance.
- 109.** Surging basically implies
- (a) unsteady, periodic and reversed flow.
 - (b) forward motion of air at a speed above sonic velocity.
 - (c) the surging action due to the blast of air produced in a compressor.
 - (d) forward movement of aircraft.
- Sol. (c)** Roots blower is mostly used for supercharging of I.C. engines.
- 110.** Which one of the following types of compressors is mostly used for supercharging of I.C. engines ?
- (a) Radial flow compressor
 - (b) Axial flow compressor.
 - (c) Roots blower
 - (d) Reciprocating compressor.
- 111.** Phenomenon of choking in compressor means
- (a) no flow of air.
 - (b) fixed mass flow rate regardless of pressure ratio.
 - (c) reducing mass flow rate with increase in pressure ratio.
 - (d) increased inclination of chord with air stream.
- Sol. (b)** Phenomenon of choking in compressor means fixed mass flow rate regardless of pressure ratio.
- 112.** Degree of reaction in an axial compressor is defined as the ratio of static enthalpy rise in the
- (a) rotor to static enthalpy rise in the stator.
 - (b) stator to static enthalpy rise in the rotor.
 - (c) rotor to static enthalpy rise in the stage.
 - (d) stator to static enthalpy rise in the stage.
- Sol. (c)** Degree of reaction in an axial compressor is defined as the ratio of static enthalpy rise in the rotor to static enthalpy rise in the stage.

113. The usual assumption in elementary compressor cascade theory is that

- (a) axial velocity through the cascade changes.
- (b) for elementary compressor cascade theory, the pressure rise across the cascade is given by equation of state
- (c) axial velocity through the cascade does not change.
- (d) with no change in axial velocity between inlet and outlet, the velocity diagram is formed.

Sol. (c) The usual assumption in elementary compressor cascade theory is that axial velocity through the cascade does not change.

114. Consider the following statements:

The volumetric efficiency of a compressor depends upon

1. clearance volume.
2. pressure ratio.
3. index of expansion.

Of these statements

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

Sol. (d) The volumetric efficiency of a compressor depends upon 1. clearance volume 2. pressure ratio. 3. index of expansion.

115. Induced draught fans of a large steam generator have

- (a) backward curved blades.
- (b) forward curved blades.
- (c) straight or radial blades.
- (d) double curved blades.

Sol. (a) Induced draught fans of a large steam generator have backward curved blades.

116. Consider the following statements pertaining to isentropic flow:

1. To obtain stagnation enthalpy, the flow need not be decelerated isentropically but should be decelerated adiabatically.
2. The effect of friction in an adiabatic flow is to reduce the stagnation pressure and increase entropy.
3. A constant area tube with rough surfaces can be used as a subsonic nozzle.

Of these statements

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

Sol. (a) All the statements are correct.

117. Consider the following statements:

A convergent-divergent nozzle is said to be choked when

1. critical pressure is attained at the throat.
2. velocity at the throat becomes sonic.
3. exit velocity becomes supersonic.

Of these statements

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

Sol. (b) A convergent divergent nozzle is said to be choked when critical pressure is attained at the throat and velocity at the throat becomes sonic.

118. In flow through a convergent nozzle, the ratio of back pressure to the inlet pressure is given by the relation

$$\frac{p_B}{p_1} = \left[\frac{2}{\gamma + 1} \right]^{\gamma / \gamma - 1}$$

If the back pressure is lower than p_B given by the above equation, then

- (a) the flow in the nozzle is supersonic.
- (b) a shock wave exists inside the nozzle.
- (c) the gases expand outside the nozzle and a shock wave appears outside the nozzle.
- (d) a shock wave appears at the nozzle exit.

Sol. (c) Statement at (c) is correct.

119. Consider the following statements :

Across the normal shock, the fluid properties change in such a manner that the

- 1. velocity of flow is subsonic.
- 2. pressure increases.
- 3. specific volume decreases.
- 4. temperature decreases.

Of these statements

- (a) 2,3 and 4 are correct
- (b) 1,2 and 4 are correct.
- (c) 1,3 and 4 are correct.
- (d) 1,2 and 3 are correct.

Sol. (d) Statements 1, 2, 3 are correct.

120. The optimum intermediate pressure p_i for a gas turbine plant operating between pressure limits p_1 and p_2 with perfect intercooling between the two stages of compression (with identical isentropic efficiency) is given by

- (a) $p_i = p_2 - p_1$
- (b) $p_i = \frac{1}{2}(p_1 + p_2)$
- (c) $p_i = \sqrt{p_1 \cdot p_2}$
- (d) $p_i = \sqrt{p_2^2 - p_1^2}$

Sol. (c) Optimum intermediate pressure p_i for a gas turbine operating between pressure limits p_1 and p_2 with perfect intercooling is $p_i = \sqrt{p_1 p_2}$.

Engineering Services Examination
MECHANICAL ENGINEERING-1996
PAPER-II (Objective)

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1. 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.
 2. You have to mark all your responses ONLY on the separate Answer Sheet provided. See directions in the Answer Sheet.
 3. All items carry equal marks. Attempt all items. Your total marks will depend only on the number of correct responses marked by you in the Answer Sheet.
-

1. Chip equivalent is increased by
- (a) an increase in side-cutting edge angle of tool
 - (b) an increase in nose radius and side cutting edge angle of tool
 - (c) increasing the rake angle of tool
 - (d) increasing the depth of cut.

Sol. (a)

2. Cubic boron nitride
- (a) has a very high hardness which is comparable to that of diamond.
 - (b) has a hardness which is slightly more than that of HSS
 - (c) is used for making cylinder blocks of aircraft engines
 - (d) is used for making optical glasses.

Sol. (a) Hardness of CBN is comparable to diamond.

3. The limit to the maximum hardness of a work material which can be machined with HSS tools even at low speeds is set by which one of the following tool failure mechanisms?
- (a) Attrition
 - (b) Abrasion
 - (c) Diffusion
 - (d) Plastic deformation under compression.

Sol. (a)

4. A machinist desires to turn a round steel stock of outside diameter 100 mm at 1000 rpm. The material has tensile strength of 75 kg/mm^2 . The depth of cut chosen is 3 mm at a feed rate of 0.3 mm/rev. Which one of the following tool materials will be suitable for machining the component under the specified cutting conditions?
- (a) Sintered carbides
 - (b) Ceramic
 - (c) HSS
 - (d) Diamond.

Sol. (b) Cutting speed in this case is 314 m / min, at which ceramic is suited.

5. Notch wear at the outside edge of the depth of cut is due to
- (a) abrasive action of the work hardened chip material.
 - (b) oxidation.
 - (c) slip-stick action of the chip
 - (d) chipping.

Sol. (c)

6. Which of the following indicate better machinabilities ?

1. Smaller shear angle
2. Higher cutting forces.
3. Longer tool life
4. Better surface finish.

(a) 1 and 3

(b) 2 and 4

(c) 1 and 2

(d) 3 and 4.

Sol. (d)

7. Small amounts of which one of the following elements/pairs of elements is added to steel to increase its machinability?

(a) Nickel

(b) Sulphur and phosphorus.

(c) Silicon

(d) Manganese and copper.

Sol. (b)

8. In turning of slender rods, it is necessary to keep the transverse force minimum mainly to

(a) improve the surface finish

(b) increase productivity

(c) improve cutting efficiency.

(d) reduce vibrations and chatter.

Sol. (d)

9. Which of the following forces are measured directly by strain gauges or force dynamometers during metal cutting?

1. Force exerted by the tool on the chip acting normally to the tool face.

2. Horizontal cutting force exerted by the tool on the work piece.

3. Frictional resistance of the tool against the chip flow acting along the tool face.

4. Vertical force which helps in holding the tool in position.

(a) 1 and 3

(b) 2 and 4

(c) 1 and 4

(d) 2 and 3.

Sol. (b)

10. Specific energy requirements in a grinding process are more than those in turning for the same metal removal rate because of the

(a) specific pressures between wheel and work being high.

(b) size effect of the larger contact areas between wheel and work.

(c) high cutting velocities.

(d) high heat produced during grinding.

Sol. (d)

11. A grinding wheel of 150 mm diameter is rotating at 3000. rpm. The grinding speed is

(a) 7.5π m/s(b) 15π m/s(c) 45π m/s(d) 450π m/s.Sol. (a) Grinding speed = $\pi \times 0.15 \times 50 = 7.5 \pi$ m/s

12. Grinding wheel is said to be loaded when the

(a) metal particles get embedded in the wheel surface blocking the interspaces between cutting grains.

(b) bonding material comes on the surface and the wheel becomes blunt.

(c) work piece being ground comes to a stop in cylindrical grinding.

(d) grinding wheel stops because of very large depth of cut

Sol. (a)

13. Which of the following statements are correct?

1. A boring machine is suitable for a job shop.

2. A jig boring machine is designed specially for doing more accurate work when compared to a vertical milling machine.

3. A vertical precision boring machine is suitable for boring holes in cylinder blocks and liners.

(a) 1, 2 and 3

(b) 1 and 2

(c) 2 and 3

(d) 1 and 3.

Sol. (c)

14. Consider the following processes of gear manufacture :

1. Milling with form cutter.

2. Rack type gear shaper (gear planer).

3. Rotary gear shaper (gear shaper).

4. Gear hobbing.

The correct sequence of these processes in increasing order of accuracy of convolute profile of the gear is

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

Sol. (a)

15. Gear cutting on a milling machine using an involute profile cutter is a
 (a) gear forming process. (b) gear generating process.
 (c) gear shaping process. (d) highly accurate gear producing process.

Sol. (a)

16. For the manufacture of full depth spur gear by hobbing process, the number of teeth to be cut = 30, module = 3 mm and pressure angle = 20° . The radial depth of cut to be employed should be equal to
 (a) 3.75 mm (b) 4.50 mm (c) 6.00 mm (d) 6.75 mm

Sol. (a)

17. Match List I with List II and select the correct answer

<i>List I (Metal forming process)</i>					<i>List II (Associated force)</i>				
A.	Wire drawing				1.	Shear force.			
B.	Extrusion				2.	Tensile force.			
C.	Blanking				3.	Compressive force.			
D.	Bending				4.	Spring back force.			
Codes :	A	B	C	D		A	B	C	D
(a)	4	2	1	3	(b)	2	1	3	4
(c)	2	3	1	4	(d)	4	3	2	1

Sol. (c)

18. In wire drawing process, the bright shining surface on the wire is obtained if one
 (a) does not use a lubricant. (b) uses solid powdery lubricant.
 (c) uses thick paste lubricant. (d) uses thin fluid lubricant.

Sol. (d)

19. Which one of the following is an advantage of forging ?
 (a) Good surface finish. (b) Low tooling cost
 (c) Close tolerance. (d) Improved physical property.

Sol. (d)

20. Consider the following ingredients used in moulding:
 1. Dry silica sand 2. Clay 3. Phenol formaldehyde 4. Sodium silicate.
 Those used for shell mould casting include
 (a) 1, 2 and 4 (b) 2, 3 and 4 (c) 1 and 3 (d) 1, 2, 3 and 4.

Sol. (c)

21. Which of the following methods are used for obtaining directional solidification for riser design?
 1. Suitable placement of chills. 2. Suitable placement of chaplets.
 3. Employing padding.
 Select the correct answer.
 (a) 1 and 2 (b) 1 and 3 (c) 2 and 3 (d) 1, 2 and 3.

Sol. (b)

22. Misrun is a casting defect which occurs due to
 (a) very high pouring temperature of the metal.
 (b) insufficient fluidity of the molten metal.

30. Assertion (A) : Special purpose machine tools and automatic machine tools are quite useful for job shops.

Reason (R) : Special purpose machine tools can do special types of machining work automatically.

Sol. (d)

31. Assertion (A) : It is desirable to increase the length of arc over which the oil film has to be maintained in a journal bearing.

Reason (R) : The oil pressure becomes negative in the divergent part and the partial vacuum created will cause air to leak in from the ends of bearing.

Sol. (c)

32. Assertion (A) : Hydraulic fluid is one form a link.

Reason (R) : A link need not necessarily be a rigid body but it must be a resistant body.

Sol. (d)

33. Assertion (A) : The Ackermann steering gear is commonly used in all automobiles.

Reason (R) : It has the correct inner turning angle θ for all positions.

Sol. (c)

34. Assertion (A) : When the coupler of a turn buckle is turned in one direction both the connecting rods either move closer or move away from each other depending upon the direction of rotation of the coupler.

Reason (R) : A turn buckle is used to connect two round rods subjected to tensile loading and requiring subsequent adjustment for tightening or loosening.

Sol. (a)

35. Assertion (A) : If the helix angle of a helical gear is increased, the load carrying capacity of the tooth increases.

Reason (R) : The form factor of a helical gear increases with the increase in the helix angle.

Sol. (a)

36. Assertion (A) : Soderberg relation is used for design against fatigue.

Reason (R) : Soderberg relation is based on yield strength of the material whereas all other failure relations for dynamic loading are based on ultimate strength of the material.

Sol. (a)

37. Assertion (A) : A long column of square cross-section has greater buckling stability than that of a circular column of same length, same material, same end conditions and of equal area of cross-section.

Reason (R) : A column of circular cross-section has lower second moment of area than a square column of equal area of cross-section.

Sol. (a)

38. Assertion (A) : A plane state of stress does not necessarily result into a plane state of strain as well.

Reason (R) : Normal stresses acting along X and Y directions will also result into normal strain along the Z-direction.

Sol. (a)

39. Assertion (A) : If the state at a point is pure shear, then the principal planes through that point making an angle of 45° with plane of shearing stress carry principal stresses whose magnitude is equal to that of shearing stress.

Reason (R) : Complimentary shear stresses are equal in magnitude, but opposite in direction.

Sol. (b)

40. Assertion (A) : Transportation problem can be solved by VAM heuristic much faster as compared to the solution through linear programming method.

Reason (R) : VAM heuristic gives an approximate solution. It is checked for optimality test. If it is optimal, the algorithm stops there. If it is not an optimal solution, then improved solutions are found out through very few iterations till optimality is reached.

Sol. (a)

41. Assertion (A) : Generally PERT is preferred over CPM for the purpose of project evaluation.

Reason (R) : PERT is based on the approach of multiple time estimates for each activity.

Sol. (a)

42. Which one of the following is an Open Pair?

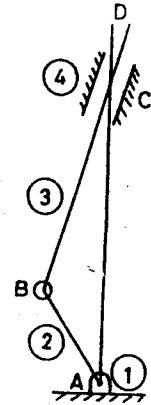
- (a) Ball and socket joint
- (b) Journal bearing
- (c) Lead screw and nut
- (d) Cam and follower.

Sol. (d) Cam and follower is open pair.

43. In the mechanism ABCD shown in the given figure, the fixed link is denoted as (1), Crank AB as (2), rocker BD as (3), Swivel trunnion at C as (4) The instantaneous centre I_{41} is at

- (a) the centre of swivel trunnion.
- (b) the intersection of line AB and a perpendicular to BD to
- (c) infinity along AC
- (d) infinity perpendicular to BD.

Sol. (d)



44. The instantaneous centre of motion of a rigid-thin-disc-wheel rolling on plane rigid surface shown in the figure, is located at the point.

- (a) A
- (b) B
- (c) C
- (d) D.

Sol. (a)

45. In a cam drive with uniform velocity follower, the slope of the displacement must be as shown in Fig. I. But in actual practice it is as shown in Fig. II (i.e. rounded at the corners).

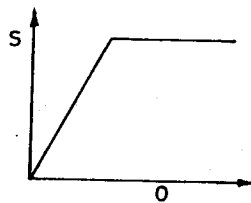
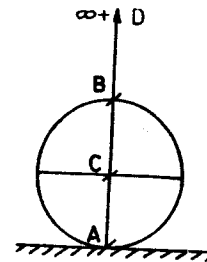


Fig. I

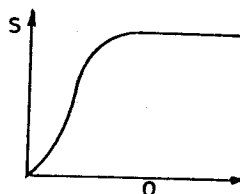


Fig. II

This is because of

- (a) the difficulty in manufacturing cam profile
- (b) loose contact of follower with cam surface

- (c) the acceleration in the beginning and retardation at the end of stroke would require to be infinitely high
- (d) uniform velocity motion is a partial parabolic motion.

Sol. (c)

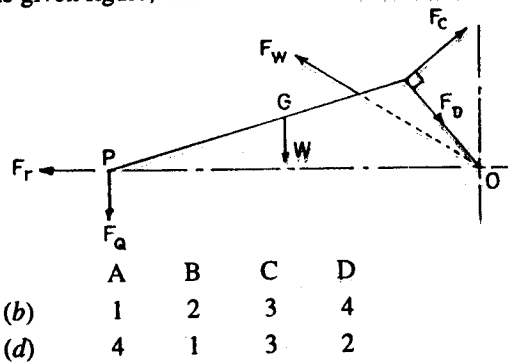
46. In a 4-stroke I.C. engine, the turning moment during the compression stroke is
- (a) positive throughout
 - (b) negative throughout
 - (c) positive during major portion of the stroke
 - (d) negative during major portion of the stroke.

Sol. (a)

47. With reference to the engine mechanism shown in the given figure, match List I with List II and select the correct answer

List I		List II	
A. F_Q	1. Inertia force of reciprocating mass		
B. F_R	2. Inertia force of connecting rod		
C. F_W	3. Crank effort		
D. F_C	4. Piston side thrust.		

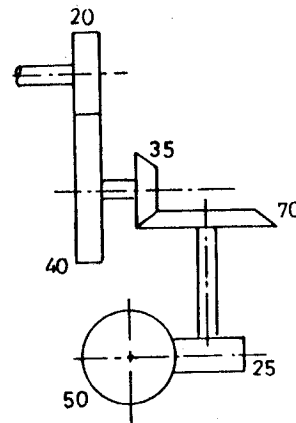
Codes :	A	B	C	D
(a)	1	2	4	3
(c)	4	1	2	3



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

Sol. (c)

48. A compound train consisting of spur, bevel and spiral gears is shown in the given figure alongwith the teeth numbers marked against the wheels. Over-all speed ratio of the train is
- (a) 8
 - (b) 2
 - (c) $\frac{1}{2}$
 - (d) $\frac{1}{8}$



Sol. (a)

49. Which of the following statements hold good for a multi-collar thrust bearing carrying an axial thrust of W units ?
1. Friction moment is independent of the number of collars.
 2. The intensity of pressure is affected by the number of collars.
 3. Co-efficient of friction of the bearing surface is affected by the number of collars.
- (a) 1 and 2
 - (b) 1 and 3
 - (c) 2 and 3
 - (d) 1, 2 and 3.

Sol. (a)

50. The centre of gravity of the coupler link in a 4-bar mechanism would experience
- (a) no acceleration.
 - (b) only linear acceleration
 - (c) only angular acceleration.
 - (d) both linear and angular accelerations.

Sol. (d)

51. Which of the following statements regarding laws governing the friction between dry surfaces are correct?
1. The friction force is dependent on the velocity of sliding.
 2. The friction force is directly proportional to the normal force.
 3. The friction force is dependent on the materials of the contact surfaces.

4. The friction force is independent of the area of contact.
 (a) 2, 3 and 4 (b) 1 and 3 (c) 2 and 4 (d) 1, 2, 3 and 4.

Sol. (a)

52. Which of the following statements are correct ?

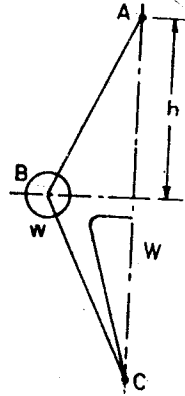
1. For constant velocity ratio transmission between two gears, the common normal at the point of contact must always pass through a fixed point on the line joining the centres of rotation of the gears.
 2. For involute gears the pressure angle changes with change in centre distance between gears.
 3. The velocity ratio of compound gear train depends upon the number of teeth of the input and output gears only.
 4. Epicyclic gear trains involve rotation of at least one gear axis about some other gear axis.
- (a) 1, 2 and 3 (b) 1, 3 and 4 (c) 1, 2 and 4 (d) 2, 3 and 4.

Sol. (c)

53. Which one of the following equation is valid with reference to the given figure.

(a) $\omega^2 = \left(\frac{W}{w}\right)\left(\frac{g}{h}\right)$
 (c) $\omega^2 = \left(\frac{w}{W+w}\right)\left(\frac{h}{g}\right)^{1/2}$

(b) $\omega^2 = \left(\frac{W+w}{w}\right)\left(\frac{g}{h}\right)^{1/2}$
 (d) $\omega^2 = \left(\frac{W+w}{w}\right)\left(\frac{g}{h}\right)$



Sol. (d)

54. Match List I with List II and select the correct answer

List I

List II

- A. Hunting
 B. Isochronism
 C. Stability
 D. Effort

1. One radius rotation for each speed.
2. Too sensitive.
3. Mean force exerted at the sleeve during change of speed.
4. Constant equilibrium speed for all radii of rotation.

Codes :

(a)

(c)

A	B	C	D
2	4	1	3
2	1	4	3

A	B	C	D
3	1	4	2
1	2	3	4

Sol. (a)

55. A system of masses rotating in different parallel planes is in dynamic balance if the resultant.

- (a) force is equal to zero (b) couple is equal to zero
 (c) force and the resultant couple are both equal to zero
 (d) force is numerically equal to the resultant couple, but neither of them need necessarily be zero.

Sol. (c)

56. When a shaking force is transmitted through the spring, damping becomes detrimental when the ratio of its frequency to the natural frequency is greater than

- (a) 0.25 (b) 0.50 (c) 1.00 (d) sqrt2.

Sol. (c)

57. When the mass of a critically damped single degree of freedom system is deflected from its equilibrium position and released, it will

- (a) return to equilibrium position without oscillation
 (b) oscillate with increasing time period
 (c) oscillate with decreasing amplitude
 (d) oscillate with constant amplitude.

Sol. (a)

58. The equation of motion for a single degree of freedom system with viscous damping is

$$4\ddot{x} + 9\dot{x} + 16x = 0$$

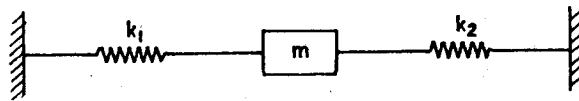
The damping ratio of the system is

- (a) $\frac{9}{128}$ (b) $\frac{9}{16}$ (c) $\frac{9}{8\sqrt{2}}$ (d) $\frac{9}{8}$

Sol. (b) $\omega_n = \sqrt{\frac{16}{4}} = 4$; $2\xi\omega_n = \frac{9}{4}$, $\xi = \frac{9}{4 \times 4} = \frac{9}{16}$

59. For the spring-mass system shown in the given figure, the frequency of oscillations of the block along the axis of the springs is

- (a) $\frac{1}{2\pi} \sqrt{\frac{k_1 - k_2}{m}}$
 (b) $\frac{1}{2\pi} \sqrt{\frac{k_1 k_2}{(k_1 + k_2) m}}$
 (c) $\frac{1}{2\pi} \sqrt{\frac{k_1 + k_2}{m}}$
 (d) $\frac{1}{2\pi} \sqrt{\frac{m}{k_1 + k_2}}$



Sol. (b)

60. The critical speed of a rotating shaft depends upon

- (a) mass (b) stiffness
 (c) mass and stiffness (d) mass, stiffness and eccentricity.

Sol. (c)

61. A fixed gear having 200 teeth is in mesh with another gear having 50 teeth. The two gears are connected by an arm. The number of turns made by the smaller gear for one revolution of arm about the centre of the bigger gear is

- (a) $\frac{2}{4}$ (b) 3 (c) 4 (d) 5.

Sol. (d) $1 + 200/50 = 1 + 4 = 5$

62. An involute pinion and gear are in mesh. If both have the same size of addendum, then there will be an interference between the

- (a) tip of the gear tooth and flank of pinion. (b) tip of the pinion and flank of gear.
 (c) flanks of both gear and pinion. (d) tips of both gear and pinion.

Sol. (a)

63. Match List I with II and select the correct answer

List I

- A. Helical gears
 B. Herring bone gears.
 C. Worm gears
 D. Hypoid Gears

Codes : A B C D

(a) 1 2 3 4

(c) 3 1 4 2

List II

1. Non-interchangeable.
 2. Zero axial thrust.
 3. Quiet motion.
 4. Extreme speed reduction.

 A B C D

(b) 3 2 1 4

(d) 3 2 4 1

Sol. (d)

64. Two rigid plates are clamped by means of bolt and nut with an initial force N . After tightening, a separating force P ($P < N$) is applied to the lower plate, which in turn acts on nut. The tension in the bolt after this is

- (a) $(N + P)$ (b) $(N - P)$ (c) P (d) N .

Sol. (a)

65. To ensure self-locking in a screw jack it is essential that helix angle is

- (a) larger than friction angle. (b) smaller than friction angle.
(c) equal to friction angle.
(d) such as to give maximum efficiency in lifting.

Sol. (b)

66. A double fillet welded joint with parallel fillet weld of length L and leg B is subjected to a tensile force P . Assuming uniform stress distribution, the shear stress in the weld is given by

- (a) $\frac{\sqrt{2} \cdot P}{B \cdot L}$ (b) $\frac{P}{2 \cdot B \cdot L}$ (c) $\frac{P}{\sqrt{2} \cdot B \cdot L}$ (d) $\frac{2P}{B \cdot L}$

Sol. (c)

67. In flat belt drive, if the slip between the driver and the belt is 1%, that between belt and follower is 3% and driver and follower pulley diameters are equal, then the velocity ratio of the drive will be

- (a) 0.99 (b) 0.98 (c) 0.97 (d) 0.96.

Sol. (d)

68. Effective stress in wire ropes during normal working is equal to the stress due to

- (a) axial load plus stress due to bending.
(b) acceleration / retardation of masses plus stress due to bending.
(c) axial load plus stress due to acceleration / retardation.
(d) bending plus stress due to acceleration/retardation.

Sol. (a)

69. A transmission shaft subjected to bending loads must be designed on the basis of

- (a) maximum normal stress theory.
(b) maximum shear stress theory.
(c) maximum normal stress and maximum shear stress theories.
(d) fatigue strength.

Sol. (a)

70. Consider the following statements:

The form factor of a spur gear tooth depends upon the

- | | |
|---------------------------------------|--------------------|
| 1. number of teeth. | 2. pressure angle |
| 3. addendum modification coefficient. | 4. circular pitch. |

Of these statements

- (a) 1 and 3 are correct (b) 2 and 4 are correct.
(c) 1, 2 and 3 are correct (d) 1 and 4 are correct.

Sol. (c)

71. When a belt drive is transmitting maximum power

- (a) effective tension is equal to centrifugal tension.
(b) effective tension is half of centrifugal tension.
(c) driving tension on slack side is equal to the centrifugal tension.
(d) driving tension on tight side is twice the centrifugal tension.

Sol. (d)

72. Tapered roller bearings can take

- (a) radial load only
- (b) axial load only
- (c) both radial and axial loads and the ratio of these being less than unity.
- (d) both radial and axial loads and the ratio of these being greater than unity.

Sol. (c)

73. In designing a plate clutch, assumption of uniform wear conditions is made because

- (a) it is closer to real life situation.
- (b) it leads to a safer design.
- (c) it leads to cost effective design
- (d) no other assumption is possible.

Sol. (a)

74. The bearing characteristic number in a hydrodynamic bearing depends on

- (a) length, width and load
- (b) length, width and speed.
- (c) viscosity, speed and load.
- (d) viscosity, speed and bearing pressure.

Sol. (d)

75. A long helical spring having a spring-stiffness of 12kN/m and number of turns 20, breaks into two parts with number of turns 10 each in both the parts. If the two parts are connected in series, then the stiffness of the resultant spring will be

- (a) 6 kN/m
- (b) 12 kN/m
- (c) 24 kN/m
- (d) 30 kN/m.

Sol. (b)

76. Consider the following statements :

State of stress at a point when completely specified, enables one to determine the

1. principal stresses at the point.
2. maximum shearing stress at the point.
3. stress components on any arbitrary plane containing the point

Of these statements

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

Sol. (d)

77. State of stress at a point in a strained body is shown in Fig. A. Which one of the figures given below represents correctly the Mohr's circle for the state of stress?

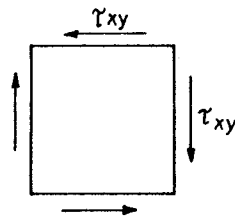
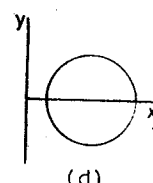
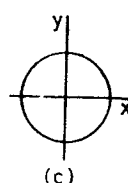
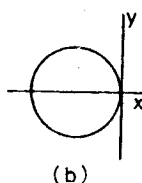
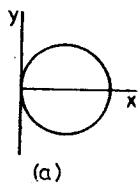


Fig. A.



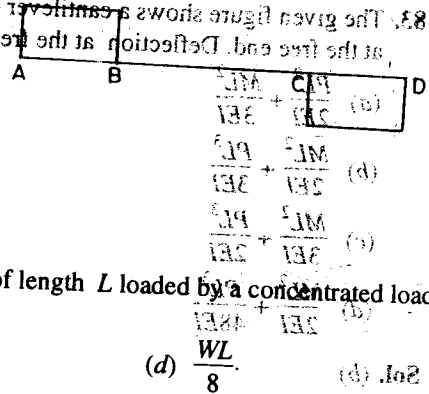
Sol. (c)

78. The given figure shows the shear force diagram for the beam ABCD.

Bending moment in the portion BC of the beam

- (a) is a non-zero constant
- (b) is zero.
- (c) varies linearly from B to C.
- (d) varies parabolically from B to C.

Sol. (c)



79. The maximum bending moment in a simply supported beam of length L loaded by a concentrated load W at the midpoint is given by

- (a) WL
- (b) $\frac{WL}{2}$
- (c) $\frac{WL}{4}$
- (d) $\frac{WL}{8}$

Sol. (c)

80. A beam, built-in at both ends, carries a uniformly distributed load over its entire span as shown in figure-I. Which one of the diagrams given below, represents bending moment distribution along the length of the beam?

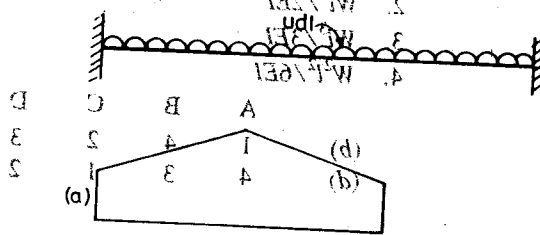
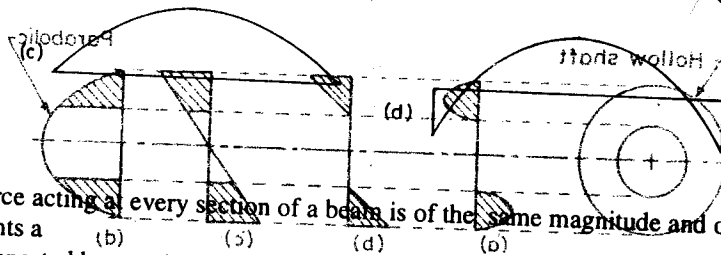


Fig-I

81. If the shear force acting at every section of a beam is of the same magnitude and of the same direction then it represents a

- (a) simply supported beam with a concentrated load at the centre.
- (b) overhung beam having equal overhang at both supports and carrying equal concentrated loads acting in the same direction at the free ends.
- (c) cantilever subjected to concentrated load at the free end.
- (d) simply supported beam having concentrated loads of equal magnitude and in the same direction acting at equal distances from the supports.

Sol. (d)



Sol. (c)

82. A cantilever beam carries a load W uniformly distributed over its entire length. If the same load is placed at the free end of the same cantilever, then the ratio of maximum deflection in the first case to that in the second case will be

- (a) $3/8$
- (b) $8/3$
- (c) $5/8$
- (d) $8/5$

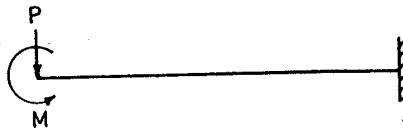
Sol. (a)

83. In a thick cylinder subjected to internal and external pressures, let r_1 and r_2 be the internal and external radii respectively. Let w be the radial displacement of a material element of a material element. Identifying the cylinder axis as z -axis, the radial strain component ϵ_r is

Sol. (a) $\frac{w}{r_1} - \frac{w}{r_2}$

83. The given figure shows a cantilever of span 'L' subjected to a concentrated load 'P' and a moment 'M' at the free end. Deflection at the free end is given by

- (a) $\frac{PL^2}{2EI} + \frac{ML^2}{3EI}$
- (b) $\frac{ML^2}{2EI} + \frac{PL^3}{3EI}$
- (c) $\frac{ML^2}{3EI} + \frac{PL^3}{2EI}$
- (d) $\frac{ML^2}{2EI} + \frac{PL^3}{48EI}$



Sol. (b)

84. For a cantilever beam of length 'L', flexural rigidity EI and loaded at its free end by a concentrated load W, match List I with List II and select the correct answer.

List I

- A. Maximum bending moment.
- B. Strain energy
- C. maximum slope
- D. maximum deflection

List II

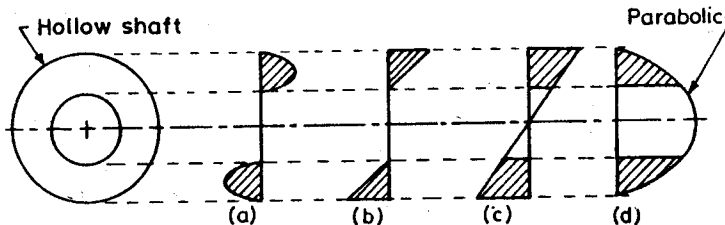
- 1. WL
- 2. $WL^2/2EI$
- 3. $WL^3/3EI$
- 4. $W^2l^2/6EI$

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

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

Sol. (b)

85. A hollow shaft is subjected to torsion. The shear stress variation in the shaft along the radius is given by



Sol. (c)

86. The equivalent bending moment under combined action of bending moment M and torque T is

- (a) $\sqrt{M^2 + T^2}$
- (b) $\frac{1}{2} \sqrt{m^2 + T^2}$
- (c) $M + \sqrt{M^2 + T^2}$
- (d) $[M + \sqrt{M^2 + T^2}]$

Sol. (d)

87. The bending moment (M) is constant over a length segment (l) of a beam. The shearing force will also be constant over this length and is given by

- (a) M/l
- (b) $M/2l$
- (c) $M/4l$
- (d) none of the above.

Sol. (a)

88. In a thick cylinder, subjected to internal and external pressures, let r_1 and r_2 be the internal and external radii respectively. Let u be the radial displacement of a material element at radius r , $r_2 \geq r \geq r_1$. Identifying the cylinder axis as z axis, the radial strain component ϵ_{rr} is

- (a) u/r (b) u/θ (c) du/dr (d) $du/d\theta$.

Sol. (a)

89. Auto frettage is the method of
 (a) joining thick cylinders. (b) calculating stresses in thick cylinders.
 (c) prestressing thick cylinders. (d) increasing the life of thick cylinders.

Sol. (c)

90. Given that

d = diameter of spring, R = mean radius of coils,
 n = number of coils and G = modulus of rigidity,

the stiffness of the close-coiled helical spring subject to an axial load W is equal to

- (a) $\frac{Gd^4}{64R^3n}$ (b) $\frac{Gd^3}{64R^3n}$ (c) $\frac{Gd^4}{32R^3n}$ (d) $\frac{Gd^4}{64R^2n}$

Sol. (a)

91. When a close-coiled helical spring is subjected to a couple about its axis, the stress induced in the wire material of the spring is
 (a) bending stress only. (b) direct shear stress only.
 (c) a combination of torsional shear stress and bending stress.
 (d) a combination of bending stress and direct shear stress.

Sol. (a)

92. If a shaft made from ductile material is subjected to combined bending and twisting moments, calculations based on which one of the following failure theories would give the most conservative value?
 (a) Maximum principal stress theory. (b) Maximum shear stress theory.
 (c) Maximum strain energy theory. (d) Maximum distortion energy theory.

Sol. (d)

93. During tensile-testing of a specimen using a Universal Testing Machine, the parameters actually measured include.
 (a) true stress and true strain. (b) Poisson's ratio and Young's modulus.
 (c) engineering stress and engineering strain. (d) load and elongation.

Sol. (d)

94. Consider the following statements :

When a metal or alloy is cold worked.

1. it is worked below room temperature.
2. it is worked below recrystallisation temperature.
3. its hardness and strength increase.
4. its hardness increases but strength does not increase.

Of these statements

- (a) 1 and 4 are correct (b) 1 and 3 are correct.
 (c) 2 and 3 are correct (d) 2 and 4 are correct.

Sol. (d)

95. Which of the following pairs regarding the effect of alloying elements in steel are correctly matched?
 1. Molybdenum : Forms abrasion resisting particles.
 2. Phosphorus : Improves machinability in free cutting steels.
 3. Cobalt : Contributes to red hardness by hardening ferrite.

4. Silicon reduces oxidation resistance.

Select the correct answer using the codes given below:

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

Sol. (a)

96. Machine tool guideways are usually hardened by

- (a) vacuum hardening (b) martempering (c) induction hardening (d) flame hardening

Sol. (b)

97. 18/8 stainless steel contains

- (a) 18% stainless, 8% chromium. (b) 18% chromium, 8% nickel.
(c) 18% tungsten, 8% nickel. (d) 18% tungsten, 8% chromium.

Sol. (b)

98. Tin base white metals are used where the bearings are subjected to

- (a) large surface wear (b) elevated temperatures.
(c) light load and pressure (d) high pressure and load.

Sol. (d)

99. Alloy steel which is work hardenable and which is used to make the blades of bulldozers, bucket wheel excavators and other earth moving equipment contain iron, carbon and

- (a) chromium (b) silicon (c) manganese (d) magnesium.

Sol. (c)

100. Consider the following statements:

Thermosetting plastics are

- formed by addition polymerisation.
- formed by condensation polymerisation.
- softened on heating and hardened on cooling for any number of times
- moulded by heating and cooling.

Of these statements

- (a) 1 and 3 are correct (b) 2 and 4 are correct
(c) 1 and 4 are correct (d) 2 and 3 are correct

Sol. (b)

101. Match List I with List II and select the correct answer

List I (Material)

- A. Polyethylene
B. Polyurethane
C. Cyano-acrylate
D. Nylon

List II (Nature of product)

- Adhesive.
- Film.
- Wire.
- Foam.

Codes : A B C D

- (a) 2 4 3 1
(c) 2 4 1 3

Sol. (c)

102. Consider the following statements:

Fibre Reinforced Plastics are

- made of thermosetting resins and glass fibre.
- made of thermoplastic resins and glass fibre.
- anisotropic.
- isotropic.

Of these statements

- (a) 1 and 4 are correct
- (b) 1 and 3 are correct
- (c) 2 and 3 are correct
- (d) 2 and 4 are correct

Sol. (b)

103. Match List I with List II and select the correct answer

List I (Object)		List II (Tool)			
A. Improving utilisation of supervisory staff		1. Micromotion study.			
B. Improving plant layout		2. Work sampling.			
C. Improving work place layout		3. Flow process chamber.			
D. Improving highly repetitive hand movements		4. Chronocyclegraph.			
Codes :	A B C D				
(a)	2 3 1 4	(b)	3 2 1 4	(c)	4 1 2 3
(c)	2 3 4 1	(d)	3 2 4 1		

Sol. (c)

104. Determination of standard time in complex job system is best done through

- (a) stop watch time study
- (b) analysis of micromotions
- (c) group timing techniques
- (d) analysis of standard data system

Sol. (d)

105. Procedure of modifying work content to give more meaning and enjoyment to the job by involving employees in planning, organisation and control of their work, is termed as

- (a) job enlargement
- (b) job enrichment
- (c) job rotation
- (d) job evaluation

Sol. (b)

106. Given that $E =$ Earnings, $R =$ Rate per hour, $T =$ Time worked in hours, $S =$ Standard time on the basis of data in hours.

Rowan wage incentive plan is

(a) $E = RT + \left(\frac{S-T}{S} \right) R$

(c) $E = RT + 0.4 \left(\frac{S-T}{S} \right) R$

Sol. (d)

107. Consider the following conditions:

1. Minimum wages should be guaranteed
2. Providing incentive to group efficiency performance
3. A differential piece rate should exist
4. All standards should be based on optimum standard of production.

Those essential for an incentive plan include

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

Sol. (b)

108. Two alternative methods can produce a product first method has a fixed cost of Rs. 2000/- and variable cost of Rs. 20/- per piece. The second method has a fixed cost of Rs. 1500/- and a variable cost of Rs. 30/- . The break even quantity between the two alternatives is

- (a) 25
- (b) 50
- (c) 75
- (d) 100.

Sol. (b)

Sol. (b) $2000 + 20n = 1500 + 30n$, $10n = 500$ and $n = 50$.

109. The routing function in a production system design is concerned with
 (a) manpower utilisation. (b) machine utilisation.
 (c) quality assurance of the product. (d) optimising material flow through the plant.

Sol. (b)

110. Match List I (type of products) with List II (type of layout) and select the correct answer.

List I				List II					
A.	Ball bearings			1.	Process layout.				
B.	Tools and gauges			2.	Product layout.				
C.	Large boilers			3.	Combination of product and process layout.				
D.	Motor cycle assembly			4.	Fixed position layout.				
Codes :	A	B	C	D		A	B	C	D
(a)	1	3	4	2	(b)	3	1	4	2
(c)	1	2	4	3	(d)	3	1	2	4

Sol. (c)

111. Given that, θ = procurement cost per order, D = number of units demanded per year, H = holding cost per unit per year, i = rate of interest, P = purchase price per unit.

the procurement quantity per order (Q) is given by

$$(a) Q = \frac{2 \cdot \theta \cdot D}{H + iP} \quad (b) Q = \sqrt{\frac{2 \cdot \theta \cdot D}{iH + P}} \quad (c) Q = \sqrt{\frac{2 \cdot \theta \cdot D}{H + iP}} \quad (d) Q = \sqrt{\frac{2 \cdot \theta}{D(H + iP)}}$$

Sol. (a)

112. Which of the following are the principles of material handling?
 1. Keep all handling to the minimum. 2. Move as few pieces as possible in one unit.
 3. Move the heaviest weight to the least distance.
 4. Select only efficient handling equipment.

Select the correct answer using the codes given below:

Codes :

$$(a) 1, 2, 3, \text{ and } 4 \quad (b) 1, 3 \text{ and } 4 \quad (c) 1, 2 \text{ and } 3 \quad (d) 2 \text{ and } 4.$$

Sol. (c)

113. A solution is not a basic feasible solution in a transportation problem if after allocations.
 (a) there is no closed loop. (b) there is a closed loop.
 (c) total number of allocations is one less than the sum of numbers of sources and destinations.
 (d) there is degeneracy.

Sol. (a)

114. Which one of the following subroutines does a computer implementation of linear programming by the simplex method use?

- (a) Finding a root of a polynomial. (b) Finding the determinant of a matrix.
 (c) Finding the eigen values of a matrix. (d) Solving a system of linear equations.

Sol. (d)

115. If the arrival rate of units is λ and the service rate is μ for a waiting line system having 'm' number of service stations, then the probability of a services unit being turned out in the time interval $(t, t + \Delta t)$ (given that there are 'n' units in the system at time 't' and 'n' being less than 'm' is equal to

$$(a) \text{ zero} \quad (b) \mu \cdot \Delta t \quad (c) m \cdot \mu \cdot \Delta t \quad (d) n \cdot \mu \cdot \Delta t$$

Sol. (b)

116. Value is usually considered as a relationship between

- (a) utility and cost
- (b) profit and cost.
- (c) psychology and reliability.
- (d) appearance and utility.

Sol. (a)

117. Aluminium tie pin and gold tie pin, both, serve the purpose of keeping the tie in position. But the gold pin has significance due to

- (a) exchange value
- (b) use value
- (c) esteem value
- (d) cost value.

Sol. (c)

118. Which of the following are the guidelines for the construction of a network diagram?

1. Each activity is represented by one and only one arrow in the network.
2. Two activities can be identified by the same beginning and end events.
3. Dangling must be avoided in a network diagram.
4. Dummy activity consumes no time or resource.

Select the correct answer using the codes given below :

Codes:

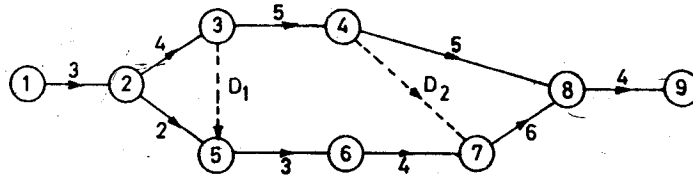
- (a) 1, 2 and 3
- (b) 1, 3 and 4
- (c) 1, 2 and 4
- (d) 2, 3 and 4.

Sol. (b)

119. In the network shown below

The critical path is along

- (a) 1-2-3-4-8-9
- (b) 1-2-3-5-6-7-8-9
- (c) 1-2-3-4-7-8-9
- (d) 1-2-5-6-7-8-9.



Sol. (b)

120. Consider the following aspects:

- 1. Speed
- 2. Decision making
- 3. Accuracy
- 4. Cost savings.

Use of computers holds substantial advantage over manual methods in the case of

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

Sol. (a)

C.E.S. (Objective)
MECHANICAL ENGINEERING-1997
PAPER-I

Time Allowed: Two Hours **Maximum Marks: 200**

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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, 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. Code:
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. Attempt ALL items. Your total marks will depend only on the number of correct responses marked by you in the Answer Sheet.
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 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 and rough sheets issued to you.

Q.1. In High pressure natural circulation boilers the flue gases flow through the following boiler accessories :

1. Superheater 2. Air heater 3. Economiser 4. I.D. fan.

The correct sequence of the flow of flue gases through these boiler accessories is :

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

Ans. (d) The correct sequence for flow of flue gases in boiler is superheater, economiser, air heater, and I.D. fan.

Q.2. Consider the following components :

1. Radiation evaporator 2. Economiser
 3. Radiation superheater 4. Convection superheater

In the case of Benson boiler, the correct sequence of the entry of water through these components is:

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

Ans. (c) The correct sequence of water entry in Benson boiler is – economiser, radiation evaporator, radiation superheater and finally convection superheater.

Q.3. Coal fired power plant boilers manufactured in India generally use :

- (a) pulverised fuel combustion (b) fluidised bed combustion
(c) circulating fluidised bed combustion (d) moving stoker firing system

Ans. (a) Coal fired power plant boilers manufactured in India generally use pulverised fuel combustion which can only offer high capacity of boilers compared to other choices.

Q.4. The net result of pressure-velocity compounding of steam turbine is :

- (a) Less number of stages (b) Large turbine for a given pressure drop
(c) Shorter turbine for a given pressure drop (d) Lower friction loss

Ans. (a) Pressure-velocity compounding of steam turbines results in less number of stages.

Q.5. Consider the following statements :

When dry saturated or slightly superheated steam expands through a nozzle,

- the coefficient of discharge is greater than unity.
- it is dry upto Wilson's line.
- expansion is isentropic throughout.

Of these statements

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

Ans. (d) C_d can't be greater than unity.

Q.6. The total and static pressures at the inlet of a steam nozzle are 186 kPa and 178 kPa respectively. If the total pressure at the exit is 180 kPa and static pressure is 100 kPa, then the loss of energy per unit mass in the nozzle will be :

- (a) 78 kPa (b) 8 kPa (c) 6 kPa (d) 2 kPa

Ans. (c) Loss = total pressure of inlet – total pressure at exit = 186 – 180 = 6 kPa.

Q.7. Given, V_b = Blade speed

V = Absolute velocity of steam entering the blade, α = Nozzle angle.

The efficiency of an impulse turbine is maximum when

- (a) $V_b = 0.5 V \cos \alpha$ (b) $V_b = V \cos \alpha$ (c) $V_b = 0.5 V^2 \cos \alpha$ (d) $V_b = V^2 \cos \alpha$

Ans. (a) The h of impulse turbine is maximum when $V_b = 0.5 V \cos \alpha$.

Q.8. An impulse turbine produces 50 kW of power when the blade mean speed is 400 m/s. What is the rate of change of momentum tangential to the rotor ?

- (a) 200 N (b) 175 N (c) 150 N (d) 125 N

Ans. (d) Power = $\frac{m(Vw_1 - Vw_2) V_b}{1000}$ kW, or $50 = \frac{m(Vw_1 - Vw_2) 400}{1000}$

$$\text{or } m(Vw_1 - Vw_2) = \text{rate of change of momentum tangential to rotor} = \frac{50 \times 1000}{400} = 125 \text{ N.}$$

Q.9. At a particular section of a reaction turbine, the diameter of the blade is 1.8 m, the velocity of flow of steam is 49 m/s and the quantity of steam flow is 5.4 m³/s. The blade height at this section will be approximately :

- (a) 4 cm (b) 2 cm (c) 1 cm (d) 0.5 cm

Ans. (b) Steam flow = $\pi D \times \text{height of blade} \times V$

$$\text{or height of blade} = \frac{5.4 \times 100}{3.14 \times 1.8 \times 49} = 2 \text{ cm.}$$

Q.10. Consider the following statements :

If steam is reheated during the expansion through turbine stages

- erosion of blade will decrease.
- the overall pressure ratio will increase.
- the total heat drop will increase.

Of these statements

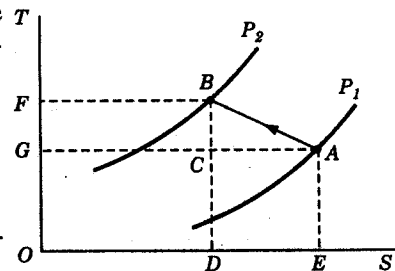
(a) 1, 2 and 3 are correct (b) 1 and 2 are correct (c) 2 and 3 are correct (d) 1 and 3 are correct

Ans. (d) Overall pressure ratio depends on inlet pressure and condenser pressure.

Q.11. The heat rejection by a reciprocating air compressor during the reversible compression process AB, shown in the following temperature-entropy diagram, is represented by the area :

- (a) ABC
(b) ABDE
(c) ABFG
(d) ABFOE

Ans. (b) Heat rejection during AB is given by area below it on entropy axis, i.e. ABDE.



Q.12. Centrifugal compressors are suitable for large discharge and wider mass flow range, but at a relatively low discharge pressure of the order of 10 bars, because of

- (a) low pressure ratio (b) limitation of size of receiver
(c) large speeds (d) high compression index

Ans. (a) Pressure ratio is low for centrifugal compressors.

Q.13. Given : Vw_2 = velocity of whirl at outlet

u_2 = peripheral velocity of the blade tips

the degree of reaction in a centrifugal compressor is equal to

- (a) $1 - \frac{Vw_2}{2u_2}$ (b) $1 - \frac{u_2}{2Vw_2}$ (c) $1 - \frac{2Vw_2}{u_2}$ (d) $1 - \frac{Vw_2}{u_2}$

Ans. (a)

Q.14. Match List-I with List-II (pertaining to blower performance) and select the correct answer using the codes given below the Lists :

List-I

- A. Slip
B. Stall
C. Choking

List-II

1. Reduction of whirl velocity
2. Fixed mass flow rate regardless of pressure ratio
3. Flow separation
4. Flow area reduction

Codes :

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

Ans. (b) Correct matching is A-1, B-3, C-2.

Q.15. In a gas turbine cycle, the turbine output is 600 kJ/kg, the compressor work is 400 kJ/kg and the heat supplied is 1000 kJ/kg. The thermal efficiency of this cycle is :

- (a) 80% (b) 60% (c) 40% (d) 20%

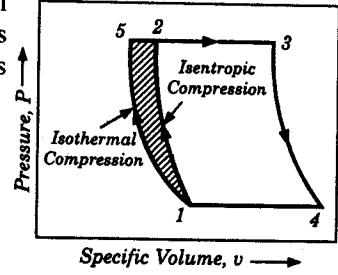
Ans. (d) $\frac{W_T - W_C}{\text{Heat}} = \frac{600 - 400}{1000} = 20\%$

Q.16. In a single-stage open-cycle gas turbine, the mass flow through the turbine is higher than the mass flow through compressor, because

- (a) the specific volume of air increases by use of intercooler
(b) the temperature of air increases in the reheater
(c) the combustion of fuel takes place in the combustion chamber
(d) the specific heats at constant pressure for incoming air and exhaust gases are different

Ans. (c) Due to combustion of fuel in combustion chamber, mass flow through turbine is higher than compressor.

Q.17. The given figure shows the effect of the substitution of an isothermal compression process for the isentropic compression process on the gas turbine cycle. The shaded area (1-5-2-1) in the p-v diagram represents :



- (a) reduction in the compression work
- (b) reduction in the specific volume
- (c) increment in the compression work
- (d) increment in the specific volume

Ans. (c) Shaded area corresponds to increment in the compression-work.

Q.18. A reaction turbine discharges 30 m³/s of water under a head of 10 m with an overall efficiency of 92%. The power developed is :

- (a) 295.2 kW
- (b) 287.0 kW
- (c) 276.0 kW
- (d) 265.2 kW

Ans.
$$\eta = \frac{\text{Power (kW)}}{\frac{wQgH}{1000}}, \text{ or } 0.92 = \frac{\text{Power} \times 1000}{1000 \times 30 \times 9.81 \times 10}$$

or
$$\text{Power} = 300 \times 0.92 \times 9.81 = 2707.6 \text{ kW.}$$

Q.19. A gas turbine develops 120 kJ of work while the compressor absorbed 60 kJ of work and the heat supplied is 200 kJ. If a regenerator which would recover 40% of the heat in the exhaust were used, then the increase in the overall thermal efficiency would be :

- (a) 10.2%
- (b) 8.6%
- (c) 6.9%
- (d) 5.7%

Ans. (d)
$$\eta = \frac{120 - 60}{200} = \frac{60}{200} = \frac{3}{10} = 30\%$$

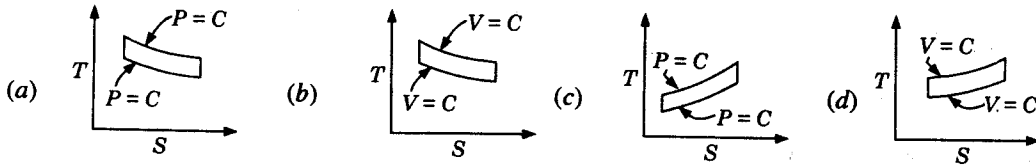
Heat in exhaust gas = 200 - 120 = 80 kJ

Heat recovery in regenerator = 0.4 × 80 = 32 kJ

Thus heat supply will reduce by 32 kJ, i.e. heat supply = 200 - 32 = 168 kJ

$$\eta = \frac{120 - 60}{168} = \frac{60}{168} = 35.7; \quad \therefore \eta \text{ increases by } 35.7\%.$$

Q.20. Which one of the thermodynamic cycles shown in the following figures represents that of Brayton cycle ?



Ans. (c) Brayton cycle is as per fig. (c).

Q.21. Given that

$N = \text{speed,}$

$P = \text{power,}$

$H = \text{head}$

The specific speed of a hydraulic turbine is given by

(a) $\frac{N\sqrt{P}}{H^{4/5}}$

(b) $\frac{N\sqrt{P}}{H^{5/4}}$

(c) $\frac{P\sqrt{N}}{H^{4/5}}$

(d) $\frac{P\sqrt{N}}{H^{5/4}}$

Ans. (b) Specific speed of turbine = $\frac{N\sqrt{P}}{H^{5/4}}$.

Q.22. As water flows through the runner of a reaction turbine, pressure acting on it would vary from :

- (a) more than atmospheric pressure to vacuum
- (b) less than atmospheric pressure to zero gauge pressure
- (c) atmospheric pressure to more than atmospheric pressure
- (d) atmospheric pressure to vacuum

Ans. (a) Pressure of water in reaction turbine runner varies from more than atmospheric to vacuum.

Q.23. Consider the following statements regarding torque converter :

1. It has a stationary set of blades in addition to the primary and secondary rotors.
2. It can be used for multiplication of torques.
3. The maximum efficiency of a converter is less than that of a fluid coupling.
4. In a converter designed to give a large increase of torque, the efficiency falls off rapidly as the speed ratio approaches unity.

Of these statements

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

Ans. (b) Statement 4 is not correct.

Q.24. In contrast to fluid couplings, torque converters are operated :

- (a) while completely filled with liquid
- (b) while partially filled with liquid
- (c) without liquid
- (d) while completely filled with air

Ans. (a) Torque converters are operated while completely filled with liquid.

Q.25. Which one of the following statements regarding an impulse turbine is correct ?

- (a) There is no pressure variation in flow over the buckets and the fluid fills the passageway between the buckets
- (b) There is no pressure variation in flow over the buckets and the fluid does not fill the passageway between the buckets
- (c) There is pressure drop in flow over the buckets and the fluid fills the passageway between the buckets
- (d) There is pressure drop in flow over the buckets and the fluid does not fill the passageway between the buckets

Ans. (a) Buckets are subjected to atmospheric pressure and fluid fills the passageway between the buckets.

Q.26. A centrifugal pump is started with its delivery valve kept

- (a) fully open
- (b) fully closed
- (c) partially open
- (d) 50% open

Ans. (a) A centrifugal pump is started with delivery valve kept open.

Q.27. When a system undergoes a process such that $\int \frac{dQ}{T} = 0$ and $\Delta S > 0$, the process is

- (a) irreversible adiabatic
- (b) reversible adiabatic
- (c) isothermal
- (d) isobaric

Ans. (d) Since $\int \frac{dQ}{T} = 0$, process is reversible. Since $\Delta S > 0$, process is constant pressure or isobaric.

Q.28. Consider the following statements :

When a perfect gas enclosed in a cylinder piston device executes a reversible adiabatic expansion process,

1. its entropy will increase.
2. its entropy change will be zero.
3. the entropy change of the surroundings will be zero.

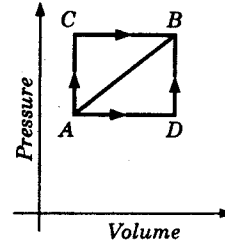
Of these statements

- (a) 1 and 3 are correct (b) 2 alone is correct (c) 2 and 3 are correct (d) 1 alone is correct

Ans. (c) In reversible adiabatic expansion, entropy change is zero and no change in entropy of surroundings.

Q.29. When a system is taken from state *A* to state *B* along the path *A-C-B*, 180 kJ of heat flows into the system and it does 130 kJ of work (see figure given) : How much heat will flow into the system along the path *A-D-B* if the work done by it along the path is 40 kJ ?

- (a) 40 kJ (b) 60 kJ
(c) 90 kJ (d) 135 kJ



Ans. (c) Change of internal energy from *A* to *B* along path *ACB* = 180 – 130 = 50 kJ. It will be same even along path *ADB*.

∴ Heat flow along *ADB* = 40 + 50 = 90 kJ

Q.30. A gas expands from pressure p_1 to pressure p_2 ($p_2 = p_1/10$). If the process of expansion is isothermal, the volume at the end of expansion is 0.55 m^3 . If the process of expansion is adiabatic, the volume at the end of expansion will be closer to

- (a) 0.45 m^3 (b) 0.55 m^3 (c) 0.65 m^3 (d) 0.75 m^3

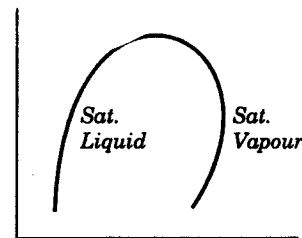
Ans. (a) For isothermal process $p_1 v_1 = p_2 v_2$, or $p_1 v_1 = \frac{p_1}{10} \times 0.55$, $v_1 = 0.055 \text{ m}^3$

For adiabatic process, $p_1 v_1^{1.4} = p_2 v_2^{1.4}$ or $p_1 (0.055)^{1.4} = \frac{p_1}{10} v_2^{1.4}$, $v_2 = 0.055 \sqrt[1.4]{10} = 0.45 \text{ m}^3$

Q.31. The ordinate and abscissa in the given figure showing the saturated liquid and vapour regions of a pure substance represent :

- (a) temperature and pressure
(b) enthalpy and entropy
(c) pressure and volume
(d) pressure and enthalpy

Ans. (d) The ordinate and abscissa in given figure are pressure and enthalpy. Such diagram is common in vapour compression refrigeration systems.



Q.32. A standard vapour is compressed to half its volume without changing its temperature. The result is that :

- (a) All the vapour condenses to liquid
(b) Some of the liquid evaporates and the pressure does not change
(c) The pressure is double its initial value
(d) Some of the vapour condenses and the pressure does not change

Ans. (d) By compressing a vapour, its vapours condense and pressure remains unchanged.

Q.33. A system of 100 kg mass undergoes a process in which its specific entropy increases from 0.3 kJ/kg-K to 0.4 kJ/kg-K . At the same time, the entropy of the surroundings decreases from 80 kJ/K to 75 kJ/K .

The process is :

- (a) Reversible and isothermal (b) Irreversible
(c) Reversible (d) Impossible

Ans. (b) Entropy increase in process = $100 (0.4 - 0.3) = 10 \text{ kJ/kg}$
Entropy change of surroundings = 5 kJ/K

Thus net entropy increases and the process is irreversible.

Q.34. The thermodynamic parameters are :

- I. Temperature II. Specific Volume III. Pressure IV. Enthalpy
V. Entropy

The Clapeyron Equation of state provides relationship between :

- (a) I and II (b) II, III and V (c) III, IV and V (d) I, II, III and IV

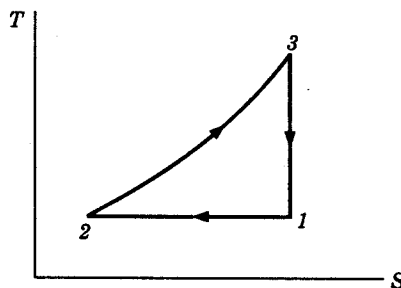
Ans. (d) Clapeyron equation state provides relationship between temperature, specific volume, pressure and enthalpy.

Q.35. The work done in compressing a gas isothermally is given by :

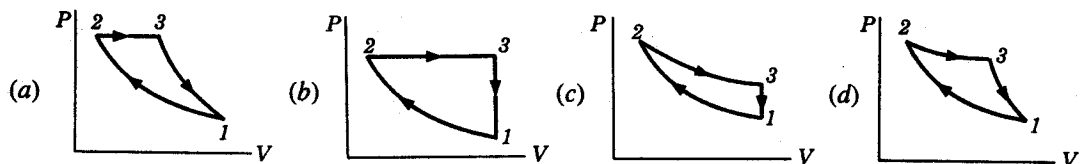
- (a) $\frac{\gamma}{\gamma-1} P_1 V_1 \left[\left(\frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}} - 1 \right]$ (b) $mRT_1 \log_e \frac{P_2}{P_1}$ N.m
(c) $mc_p (T_2 - T_1)$ kJ (d) $mRT_1 \left(1 - \frac{T_2}{T_1} \right)$ kJ

Ans. (b) Work done in isothermal compression = $mRT_1 \log_e \frac{P_2}{P_1}$ N.m.

Q.36. An ideal air standard cycle is shown in the given temperature-entropy diagram.



The same cycle, when represented on the pressure-volume coordinates takes the form,



Ans. (a) Fig. (a) matches.

Q.37. In a Rankine cycle, with the maximum steam temperature being fixed from metallurgical considerations, as the boiler pressure increases

- (a) the condenser load will increase
(b) the quality of turbine exhaust will decrease
(c) the quality of turbine exhaust will increase
(d) the quality of turbine exhaust will remain unchanged

Ans. (b) With increase in pressure, state of steam shifts towards left and thus on expansion, quality of steam will decrease.

Q.38. Match List-I (details of the processes of the cycle) with List-II (name of the cycle) and select correct answer using the codes given below the Lists :

List-I

- A. Two isothermals and two adiabatic
 B. Two isothermals and two constant volumes
 C. Two adiabatics and two constant volumes
 D. Two adiabatics and two constant pressures

Codes :

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

Ans. (c)

List-II

1. Otto
 2. Joule
 3. Carnot
 4. Stirling

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

Q.39. A refrigerating machine working on reversed Carnot cycle takes out 2 kW per minute of heat from the system while between temperature limits of 300 K and 200 K. C.O.P. and Power consumed by the cycle will be respectively :

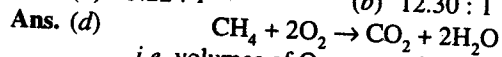
- (a) 1 and 1 kW (b) 1 and 2 kW (c) 2 and 1 kW (d) 2 and 2 kW

Ans. (c) COP of Reversed Carnot cycle = $\frac{200}{300-200} = 2$

Also COP = $\frac{\text{Heat absorbed}}{\text{work input}}$, or $2 = \frac{2}{W}$, and $W = 1 \text{ kW}$

Q.40. If methane undergoes combustion with the stoichiometric quantity of air, the air-fuel ratio on molar basis would be :

- (a) 15.22 : 1 (b) 12.30 : 1 (c) 14.56 : 1 (d) 9.52 : 1



i.e. volumes of O_2 are required for 1 volume of methane

\therefore air fuel ratio = $\frac{2}{21} \times 100 = 9.52\%$

Q.41. The presence of nitrogen in the products of combustion ensures that :

- (a) complete combustion of fuel takes place (b) incomplete combustion of fuel occurs
 (c) dry products of combustion are analysed (d) air is used for the combustion

Ans. (d) Nitrogen in flue gas means air is used for combustion.

Q.42. For maximum specific output of a constant volume cycle (Otto cycle)

- (a) the working fluid should be air (b) the speed should be high
 (c) suction temperature should be high
 (d) temperature of the working fluid at the end of compression and expansion should be equal

Ans. (a) Working fluid should be air for maximum specific output of Otto cycle.

Q.43. A two-stroke engine has a speed of 750 rpm, A four-stroke engine having an identical cylinder size runs at 1500 rpm. The theoretical output of the two-stroke engine will

- (a) be twice that of the four-stroke engine (b) be half that of the four-stroke engine
 (c) be the same as that of the four-stroke
 (d) depend upon whether it is a C.I. or S.I. engine

Ans. (c) In two-stroke engine there is one power stroke in 2 strokes, but in four-stroke engine there is one power stroke in 4 strokes.

Q.44. For same power output and same compression ratio, as compared to two-stroke engines, four-stroke S.I. engines have :

- (a) higher fuel consumption
- (b) lower thermal efficiency
- (c) higher exhaust temperatures
- (d) higher thermal efficiency

Ans. (d) Efficiency of 4 stroke engine is higher because of better utilisation compared to 2 stroke engine.

Q.45. In a SI Engine, which one of the following is the correct order of the fuels with increasing detonation tendency ?

- (a) Paraffins, Olefins, Naphthenes, Aromatics
- (b) Aromatics, Naphthenes, Paraffins, Olefins
- (c) Naphthenes, Olefins, Aromatics, Paraffins
- (d) Aromatics, Naphthenes, Olefins, Paraffins

Ans. (a)

Q.46. Consider the following statements :

Detonation in the S.I. engine can be suppressed by

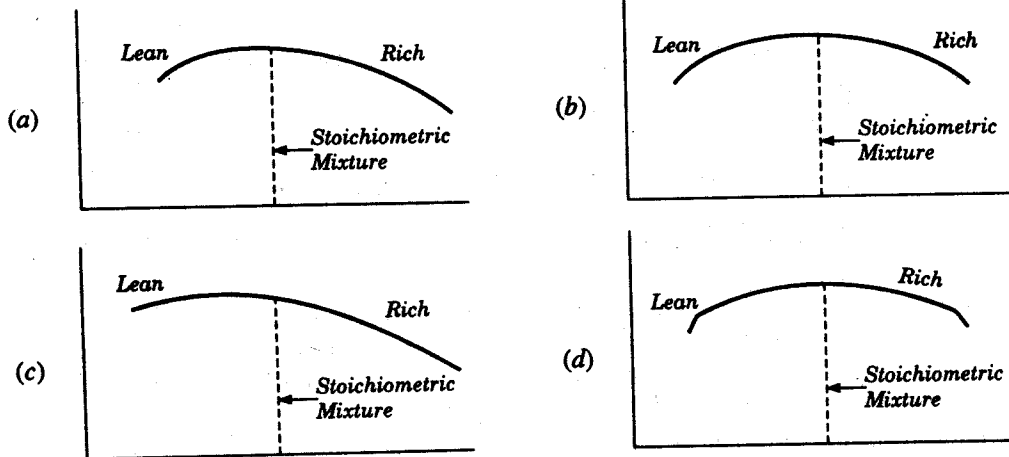
1. retarding the spark timing.
2. increasing the engine speed.
3. using 10% rich mixture.

Of these statements

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

Ans. (a) Decreasing the engine speed increases possibility of detonation.

Q.47. Which one of the following figures correctly represents the variation of thermal efficiency (y-axis) with mixture strength (x-axis) ?



Ans. (a) For higher thermal efficiency, the mixture strength should be little leaner than stoichiometric.

Q.48. Match List-I with the performance curves and select the correct answer using the codes given below the List :

List-I
(Performance parameter of an I.C. engine)

- A. Indicated power
- B. Volumetric efficiency
- C. Brake power
- D. Specific fuel consumption

List-II
Performance curves

