

SECTION - A

1. This question consists of TWENTY-FIVE sub-questions (1.1 – 1.25) of ONE mark each. For each of these sub-questions, four possible alternatives (A, B, C and D) are given, out of which ONLY ONE is correct. Indicate the correct answer by darkening the appropriate bubble against the question number on the left hand side of the Objective Response Sheet (ORS). You may use the answer book provided for any rough work, if needed.

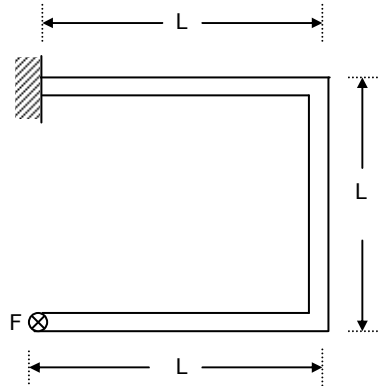
- 1.1 Rank of the matrix given below is:

$$\begin{bmatrix} 3 & 2 & -9 \\ -6 & -4 & 18 \\ 12 & 8 & -36 \end{bmatrix}$$

- (a) 1 (b) 2 (c) 3 (d) $\sqrt{2}$
- 1.2 For the function $\phi = ax^2y - y^3$ to represent the velocity potential of an ideal fluid, $\nabla^2\phi$ should be equal to zero. In that case, the value of 'a' has to be:
 (a) -1 (b) 1 (c) -3 (d) 3
- 1.3 If the velocity vector in a two-dimensional flow field is given by $\vec{v} = 2xy\vec{i} + (2y^2 - x^2)\vec{j}$, the vorticity vector, $\text{curl } \vec{v}$ will be
 (a) $2y^2\vec{j}$ (b) $6y\vec{k}$ (c) zero (d) $-4x\vec{k}$
- 1.4 Laplace transform of $(a + bt)^2$ where 'a', and 'b' are constants is given by:
 (a) $(a + bs)^2$ (b) $\frac{1}{(a + bs)^2}$
 (c) $\frac{a^2}{s} + \frac{2ab}{s^2} + \frac{2b^2}{s^3}$ (d) $\frac{a^2}{s} + \frac{2ab}{s^2} + \frac{b^2}{s^3}$
- 1.5 Following are the values of a function $y(x): y(-1)=5, y(0), y(1)=8, \frac{dy}{dx}$ at $x = 0$ as per Newton's central difference scheme is:
 (a) 0 (b) 1.5 (c) 2.0 (d) 3.0
- 1.6 Analysis of variance is concerned with:
 (a) determining change in a dependent variable per unit change in an independent variable
 (b) determining whether a qualitative factor affects the mean of an output variable

- (c) determining whether significant correlation exists between an output variable and an input variable
- (d) determining whether variances in two or more populations are significantly different.

1.7 A concentrated force, F , is applied (perpendicular to the plane of the figure) on the tip of the bent bar shown in Fig.1.7. The equivalent load at a section close the fixed end is:



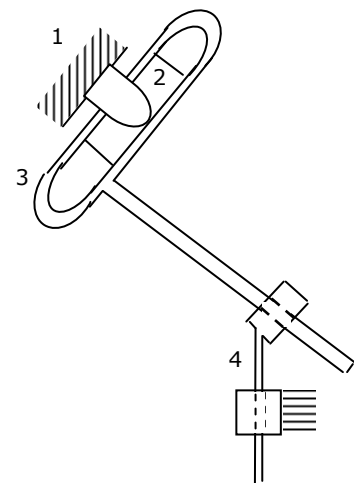
- (a) Force F
- (b) Force F and bending moment FL
- (c) Force F and twisting moment FL
- (d) Force F , bending moment $F L$, and twisting moment FL

1.8 Which theory of failure will you use for aluminium components under steady loading:

- (a) Principal stress theory
- (b) Principal strain theory
- (c) Strain energy theory
- (d) Maximum shear stress theory

1.9 For the planar mechanism shown in Fig.1.9, select the most appropriate choice for the motion of link 2 when link 4 is moved upwards.

- (a) Link 2 rotates clockwise
- (b) Link 2 rotates counter - clockwise
- (c) Link 2 does not move
- (d) Link 2 motion cannot be determined



- 1.10 $\frac{\partial^2 u}{\partial t^2} = C^2 \frac{\partial^2 u}{\partial x^2}$ represents the equation for:
- Vibration of a stretched string
 - Motion of a projective in a gravitational field
 - Heat flow in thin rod
 - Oscillation of a simple pendulum
- 1.11 Bolts in the flanged end of pressure vessel are usually pre-tensioned. Indicate which of the following statements in NOT TRUE.
- Pre-tensioning helps to seal the pressure vessel
 - Pre-tensioning increases the fatigue life of the bolts
 - Pre-tensioning reduces the maximum tensile stress in the bolts
 - Pre-tensioning helps to reduce the effect of pressure pulsations in the pressure vessel
- 1.12 If 'p' is the gauge pressure within a spherical droplet, the gauge pressure within a bubble of the same fluid and of same size will be
- $\frac{p}{4}$
 - $\frac{p}{2}$
 - p
 - $2p$
- 1.13 If velocity of water inside a smooth tube is doubled, the turbulent flow heat transfer coefficient between the water and the tube will
- remain unchanged
 - increase to double its value
 - increase but will not reach double its value
 - increase to more than double its value
- 1.14 A Stirling cycle and a Carnot cycle operate between 50°C and 350°C. Their efficiencies are η_s and η_c respectively. In this case, which of the following statements is true?
- $\eta_s > \eta_c$
 - $\eta_s = \eta_c$
 - $\eta_s < \eta_c$
 - The sign of $(\eta_s - \eta_c)$ depends on the working fluids used
- 1.15 A Carnot cycle refrigerator operates between 250 K and 300 K. Its coefficient of performance is:
- 6.0
 - 5.0
 - 1.2
 - 0.8

- 1.16 In a pulverized-fuel-fired large power boiler, the heat transfer from the burning fuel to the walls of the furnace is
(a) by conduction only (b) by convection only
(c) by conduction and convection (d) predominantly by radiation
- 1.17 A gas turbine power plant has a specific output of 350 kJ/kg and an efficiency of 34%. A regenerator is installed and the efficiency increases to 51%. The specific output will be closest to
(a) 350 kJ/kg (b) 468 kJ/kg (c) 525 kJ/kg (d) 700 kJ/kg
- 1.18 Kinematic viscosity of air at 20°C is given to be $1.6 \times 10^{-5} \text{ m}^2 / \text{s}$. Its kinematic viscosity at 70°C will be vary approximately
(a) $2.2 \times 10^{-5} \text{ m}^2 / \text{s}$ (b) $1.6 \times 10^{-5} \text{ m}^2 / \text{s}$
(c) $1.2 \times 10^{-5} \text{ m}^2 / \text{s}$ (d) $10^{-5} \times \text{m}^2 / \text{s}$
- 1.19. Which of the following statements does NOT apply to the volumetric efficiency of a reciprocating air compressor
(a) It decreases with increase in inlet temperature
(b) It increases with decrease in pressure ratio
(c) It increases with decrease in clearance ratio
(d) It decreases with increase in clearance to stroke ratio
- 1.20. Ambient air dry-bulb temperature is 45°C and wet bulb temperature is 27°C. Select the lowest possible condensing temperature from the following for an evaporatively cooled condenser.
(a) 25°C (b) 30°C (c) 42°C (d) 48°C
- 1.21. Identify the stress –state in the FLANGE portion of a PARTIALLY DRAWN CYLINDRICAL CUP when deep – drawing without a blank holder
(a) Tensile in all three directions
(b) No stress in the flange at all, because there is no blank - holder
(c) Tensile stress in one direction and compressive in the other direction
(d) Compressive in two directions and tensile in the third direction
- 1.22. Which of the following materials requires the largest shrinkage allowance, while making a pattern for casting?
(a) Aluminium (b) Brass
(c) Cast Iron (d) Plain Carbon Steel

- 1.23. In Electro-Discharge Machining (EDM), the tool is made of:
- (a) Copper (b) High Speed Steel
(c) Cast Iron (d) Plain Carbon Steel
- 1.24. Choose the correct statement:
- (a) A fixture is used to guide the tool as well as to locate and clamp the work piece
(b) A jig is used to guide the tool as well as to locate and clamp the work piece
(c) Jigs are used on CNC machines to locate and clamp the work piece and also to guide the tool
(d) No arrangements to guide the tool is provided in a jig
- 1.25 The first algorithm for Linear Programming was given by:
- (a) Bellman (b) Dantzing
(c) Kulm (d) von Neumann

2. This question consists of TWENTY-FIVE sub-questions (2.1 – 2.25) of TWO marks each. For each of these sub-questions, four possible alternatives (A, B, C and D) are given, out of which ONLY ONE is correct. Indicate the correct answer by darkening the appropriate bubble against the question number on the left hand side of the Objective Response Sheet (ORS). You may use the answer book provided for any rough work, if needed.

2.1 The eigen values of the matrix

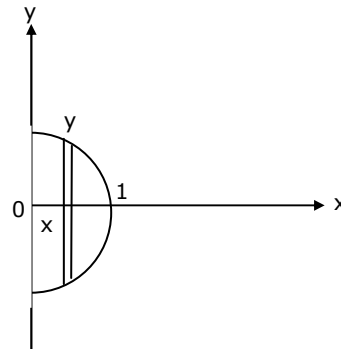
$$\begin{bmatrix} 5 & 3 \\ 3 & -3 \end{bmatrix} \text{ are:}$$

- (a) 6 (b) 5 (c) -3 (d) -4

2.2. The static moment of the area of a half circle of unit radius about y-axis (see

Fig.2.2) $\int_0^1 2xy dx$ is equal to

- (a) $\frac{2}{3}$ (b) $\frac{\pi}{8}$
(c) $\frac{\pi}{2}$ (d) $\frac{\pi}{4}$



- 2.3. In a flow field in x, y - plane, the variation of velocity with time t is given by
$$v = (x^2 + yt)\vec{i}$$

$$\vec{v} = (x^2 + y^2)\vec{i}$$

The acceleration of the particle in this field, oc



