Gate XE-2019

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14) If the transformation $u(x,t) = e^x v(x,t)$ reduces the partial differential equation

$\frac{\partial^2 u}{\partial x^2} - 2\frac{\partial u}{\partial x} - \frac{\partial u}{\partial x} + u = 9$ to the equation $\frac{\partial v}{\partial t} - \frac{\partial^2 v}{\partial x^2} = 9$ f (x) then f(x) equals

a) $-e^{-x}$ b) e^{-x} c) $-2e^{-x}$ d) $2e^{-x}$

15) The value of a for which the system of equations

$$\begin{aligned} x - y - 3z &= 3 \\ 2x + z &= 0 \\ -2y - 7z &= \alpha \end{aligned}$$

has a solution is _____.

16) The value of the line integral $\frac{2}{\pi}\oint_\gamma \left(-y^3 dx + x^3 dy\right)$, where γ is the circle $x^2 + y^2 = 1$ oriented counter clockwise,is _____.

17) Let $y_1(x)$ and $y_2(x)$ be two linearly independent solutions of the differential equation $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - 4y = 0, x > 0$ If $y_1(x) = x^2$, then $\lim_{x\to\infty} y_2(x)$ is _____.

18) If $\mathrm{Q} = \begin{pmatrix} 3 & 2 & 4 \\ 2 & 0 & 2 \\ 4 & 2 & 3 \end{pmatrix}$ and $\mathrm{P} = (v_1, v_2, v_3)$ is the matrix where v_1, v_2 and v_3 are linearly independent eigenvector of the matrix Q, then the sum of the absolute values of all the elements of the matrix $\mathrm{P}^{-1}\mathrm{QP}$

a) 6 b) 10 c) 14 d) 22

19) If $\mathrm{P}(x) = ax^3 + bx^2 + cx + d$ is the polynomial obtained by Lagrange interpolation satisfying $P(0) = -8, P(1) = -7, P(2) = -6$ and $P(4) = 20$ hen the value of $a+b+c$ is

a) 1 b) 3 c) 5 d) 7

20) The number of critical points of the function $f(x, y) = x^3 + 3xy^2 - 15x - 12y$ at which there is neither maximum nor minimum is _____.

21) Let $I = \frac{10^5 i}{2\pi} \oint_\gamma \frac{dz}{(z-4)(z^7-1)}$, where $i = \sqrt{-1}$ and γ is the circle $z = 2$ oriented counter clockwise. Then, the value of I rounded off to one decimal place

22) For stable equilibrium of a floating body, which one of the following statements is correct?
   a) Centre of gravity must be located below the centre of buoyancy.
   b) Centre of buoyancy must be located below the centre of gravity.
   c) Metacentre must be located below the centre of gravity.
   d) Centre of gravity must be located below the metacentre.

23) f u and v are the velocity components in the x- and y-directions respectively, the z-component of vorticity ω_z at a point in a flow field is

   a) $\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}$ b) $\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$ c) $\frac{\partial v}{\partial y} + \frac{\partial u}{\partial x}$ d) $\frac{\partial v}{\partial y} - \frac{\partial u}{\partial x}$

24) In which one of the following devices the difference between static and total pressure is used to determine the flow velocity?

   a) Piezometer b) Pitot static tube c) Orificemeter d) Venturimeter

25) A golf ball is dimpled to make the flow turbulent and consequently to reduce the drag. Turbulent flow reduces the drag on the golf ball because
   a) skin friction coefficient is lower in a turbulent flow.
   b) skin friction coefficient is higher in a turbulent flow.
   c) turbulent flow has a lower tendency to separate.
   d) turbulent flow has a higher tendency to separate.

26) For a steady laminar incompressible boundary layer flow over a sharp-edged flat plate at zero incidence,
   a) the edge of the boundary layer is a streamline.
   b) the edge of the boundary layer is a pathline.
   c) he skin friction coefficient decreases as the distance from the leading edge increases.
   d) the skin friction coefficient remains constant all along the plate.