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(1) Solve $\frac{dy}{dx} + 2xy = 2x^2+1$ $(\frac{10}{100})$

(2) Find the unit normal vector to the surface : $x^2y+2xz = 4$ at $(2,-2,3)$ $(\frac{10}{100})$

(3) Evaluate $I = \int_C (2y\,\hat{i} + z\,\hat{j} + 3y\,\hat{k})\cdot d\bar{r}$

where C is the intersection of $x^2+y^2+z^2=4z$ and $z = x+2$, in a clockwise direction to an observer at the origin. $(\frac{10}{100})$

(4) Find the eigenvalues and eigenvectors of $\begin{pmatrix} -1 & 4 & -2 \\ 0 & 3 & -2 \\ 0 & 4 & -3 \end{pmatrix}$. $(\frac{15}{100})$

(5) Find the Fourier transform of

(i) $\frac{a}{x^2+a^2}$, $(a>0)$; (ii) $\frac{a}{(x-b)^2+a^2}$, $(a>0)$ $(\frac{15}{100})$

(6) Find the extremal and the stationary value of

$$I = \int_0^{\pi/2} (y^2 + (y')^2 - 2y\sin x)\,dx, \quad y(0)=0,\ y(\tfrac{\pi}{2})=1$$

$(\frac{15}{100})$

(7) Find all the power series (Laurent series) at the singular points of $f(z) = \frac{1}{z^2(z-1)}$, each valid in the largest possible annulus. $(\frac{15}{100})$

(8) Find $P_n(0)$, where $P_n(x)$ is the Legendre polynomial of degree n.

$(\frac{10}{100})$