Department of Physics

Electrodynamics and Optics (PH005)

Tuturial 1 (July 30 , 2019)

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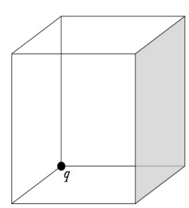
(1) For an observer moving with velocity $v_1 = 20\,\mathrm{km/h}$ in the positive x-direction, the wave equation is $y = A \sin k(x - vt)$ and for another observer moving along the same direction with velocity $v_2 = 40\,\mathrm{km/h}$, the equation is $y^{'} = A \sin k(x^{'} + vt)$. Calculate the actual velocity of the wave.

(2) Find the gradients of following functions:
a) $f(x, y, z) = x^2 + y^3 + z^4$
b) $f(x, y, z) = x^2y^3z^4$
c)$f(x, y, z) = e^x \sin(y) \ln(z)$
(Problem: 1.11 Griffith)

(3) Prove that $\nabla.(\nabla \times \mathbf{V}) = \mathbf{0}$. Check it for $f(x) = xy\,\hat{i} + 2yz\,\hat{j} + 3zx\,\hat{k}$
b) Prove that $\nabla \times (\nabla f) = 0$.

(4) Which one can not be an electrostatic field?
(a) $\mathbf{E}_1 = (\mathrm{y}\hat{\imath} + \mathrm{z}^3\hat{\jmath} + \mathrm{x}^2\hat{k})$
(b) $\mathbf{E}_2 = (\mathrm{x}^2\hat{\imath} + 2\mathrm{yz}\hat{\jmath} + \mathrm{y}^2\hat{k})$

(5) Calculate the flux of $\mathbf{E}$ through shaded region due to charge q at the corner of the cube shown in following figure



(Problem: 3.2 Griffith)

(6) Using Gauss's law, find the electric field inside a uniformly charged sphere at radial distance r_1 from origin(r_1<R). R is radius of the sphere. Volume charge density of the sphere is ρ. Also find electric field outside the sphere at radial distance r_2 (r_2>R). Plot $|\mathbf{E}|$ as a function of r.

(7) Is curl of a vector field is always orthogonal to the vector field. Justify your argument with example.

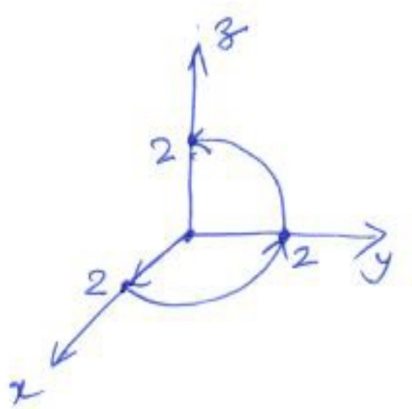
(8) Calculate the divergence and curl of the following vector fields;

(a) $\mathbf{A}(\mathbf{r})$=-$\frac{y}{x^2+y^2}\hat{\imath} + \frac{x}{x^2+y^2}\hat{\jmath}$

(b) $\mathbf{A}(\mathbf{r})$=-$\frac{x}{x^2+y^2}\hat{\imath} + \frac{y}{x^2+y^2}\hat{\jmath}$

(b) Let C be a circle of unit radius in the x-y plane, enclosing the unit surface a=S having a vector field $\mathbf{A} = \mathbf{y}\hat{\imath}$ Calculate the line integral of $\mathbf{A}$ around C and (ii) the flux of $\nabla \times \mathbf{A}$ through S.

(9) Calculate the gradient and Laplacian of the function $T = r(cos\theta + sin\theta cos\phi)$. Check the Laplacian by converting to Cartesian coordinates. Test the gradient theorem fir this function using the path shown in following figure



(Problem: 1.39 Griffith)

10 A vector field is defined by $\mathbf{A}(x,y) = xy^2\hat{\imath} + (x+y)\hat{\jmath}$ and surface S is surrounded by the curves $y = x^2$ and $y = x$ Calculate $\iint_S (\nabla \times \mathbf{A}).d\mathbf{s}$ also repeat the calculation for surface bound by the curves $y = x^2$, $y = -x^2$ and $x = 1$.