

2022-02-28

Return solutions by 20:00, 6 March 2022 — electronically in MyCourses

Remember to produce a clear homework document!**Explain your reasoning when going from one step to the next towards the final solution.**

1. (a) Compute the distance from Otaniemi to Paris on the surface of Earth. The coordinates are (latitude and longitude in degrees and arc-minutes) the following: Otaniemi – (60°11'N, 24°50'E) and Paris – (48°52'N, 2°21'E)

It is useful in the calculation to use the spherical coordinate system, set in the manner that the origin is in the center of the Earth and z -axis going through the North pole. Use the value 6370 km for the radius of Earth.



- (b) The curl $\nabla \times \mathbf{F}$ of the vector field \mathbf{F} is another vector field, connected to the properties of \mathbf{F} . The curl can be computed in different coordinate systems. But these systems are only frames, and the resulting vector function is independent of the used coordinate system. Hence the result should be independent of the coordinate frame used.

Consider the simple vector function $\mathbf{F}(\mathbf{R}) = \mathbf{a}_\phi$ (one the unit vectors in the cylindrical and spherical coordinate systems). Note that even if the magnitude of this function is unity everywhere, its direction changes (except on the z axis where \mathbf{a}_ϕ is undefined).

- i. Compute $\nabla \times \mathbf{a}_\phi$ in the cylindrical coordinate system.
 - ii. Compute $\nabla \times \mathbf{a}_\phi$ in the Cartesian coordinate system (in other words, expand the unit vector \mathbf{a}_ϕ in terms of x, y, z coordinates and calculate the divergence using Equation (2-95) in the textbook).
 - iii. Compare the results.)
- (c) You are pursuing the study programme of Quantum Technology.

Electromagnetism as a scientific discipline is often treated as part of classical physics, rather than modern physics.

Tell about your feelings how electromagnetics could be connected to your studies in the coming years.

What do you expect from this course?