Exercises

Assignment #6

1. The divergence of a vector field results in a scalar quantity.
   I. True
   II. False

2. Given a vector \[ \overrightarrow{A} = 2\hat{x} + 3\hat{y} + 4\hat{z}, \] the divergence of the vector is
   I. 9
   II. 0
   III. \( \vec{0} \) (Null vector)

3. The divergence of \( \overrightarrow{F} = x^2\hat{x} + x y\hat{y} + 4\hat{z} \) is
   I. 3x
   II. 3x + 4
   III. 3x\hat{x} + 4\hat{z}
   IV. 2x\hat{x} + x\hat{y}

4. In a certain closed region in space, the integral \( \oint \overrightarrow{D} \cdot d\overrightarrow{s} \) is +3 units. This indicates
   I. that the region encloses a net positive charge of 3 units
   II. that the region encloses a net negative charge of 3 units
   III. there is an equal amount of positive and negative charges in the region
   IV. divergence of \( \overrightarrow{D} \) is zero

5. Given scalar field \( f(x, y, z) \) and vector field \( \overrightarrow{D}(x, y, z) \) which of the following operations is not allowed?
   I. \( \nabla f \cdot \overrightarrow{D} \)
   II. \( \nabla \cdot (f\overrightarrow{D}) \)
   III. \( f(\nabla \cdot \overrightarrow{D}) \)
   IV. \( (\nabla \times f) \cdot \overrightarrow{D} \)

6. A vector field is solenoidal if
   I. its divergence is zero everywhere
   II. its curl is zero everywhere
   III. the magnitude of its gradient is unity everywhere

7. A vector field is irrotational if
   I. its divergence is zero everywhere
   II. its curl is zero everywhere
   III. the magnitude of its gradient is unity everywhere
8. According to Coulomb's law, the intensity of the electric field of a point charge kept at the origin

I. is proportional to inverse square of the distance from the charge
II. is directly proportional to square of the distance from the charge
III. independent of the test charge

9. The vector field \( \vec{G}(x, y, z) = 2y \hat{x} \) has zero curl.

I. True
II. False

10. The magnetic field \( \vec{H} \) of a current-carrying wire is given by \( \vec{\phi}(K/r) \), where \( K \) is a constant. The curl of \( \vec{H} \) is

I. \( 2K \) when \( r \neq 0 \)
II. \( 2\pi K \) when \( r \neq 0 \)
III. \( 0 \) if \( r \neq 0 \)
IV. is infinite at \( r = 0 \)

11. Given scalar field \( f(x, y, z) \) and vector field \( \vec{D}(x, y, z) \) what is \( \nabla \times f \vec{D} \)?

I. \( (\nabla \times f) \cdot \vec{D} \)
II. \( (\nabla f) \times \vec{D} \)
III. \( (\nabla f) \times \vec{D} + f \nabla \times \vec{D} \)

12. Identify Gauss's law for electrostatics from the following.

I. \( \nabla \cdot \vec{E} = \rho \)
II. \( \nabla \cdot \vec{E} = \rho / \varepsilon_0 \)
III. \( \nabla \cdot \vec{D} = \rho / \varepsilon_0 \)
IV. \( \nabla \cdot \vec{D} = 0 \)

13. Identify Gauss's law for magnetostatics from the following.

I. \( \nabla \cdot \vec{B} = \vec{j} \)
II. \( \nabla \cdot \vec{B} = 0 \)
III. \( \nabla \times \vec{B} = 0 \)
IV. \( \nabla \times \vec{H} = 0 \)

14. Identify Ampere's law for magnetostatics from the following.

I. \( \nabla \times \vec{B} = \mu_0 \vec{j} \)
II. \( \nabla \cdot \vec{B} = 0 \)
III. \( \nabla \times \vec{H} = \vec{j} / \mu_0 \)
IV. \( \nabla \cdot \vec{H} = 0 \)
15. The magnitude of the electric field of a point charge is found to be $E_0$ V/m. If the charge is now doubled, what happens to the magnitude to the electric field at the same point?

I. Magnitude remains same  
II. Magnitude doubles  
III. Magnitude halves

16. A charge $q$ is moving in a magnetic field $B\hat{y}$ with uniform velocity along $x$-direction. The force experienced by the charge is along

I. $z$-direction  
II. $x$-direction  
III. $y$-direction