List 1

№1

$\bar{A}\,(2x+2yz^2,\ 5z,\ 2xy)$
$\bar{B}\,(x^3,\ yx^3,\ zx^3)$
$\bar{C}\,(xyz,\ xyz,\ xyz)$
$\bar{D}\,(x,\ y,\ z)$

Scalar product:

$\bar{A}\cdot\bar{B} = (2x+2yz^2)\cdot x^3 + 5z\cdot yx^3 + 2xy\cdot zx^3 =$
$= 2x^4 + 2x^3yz^3 + 5x^3yz + 2x^4yz$

$\bar{C}\cdot\bar{D} = x^2yz + xy^2z + xyz^2$

Dot product:

Cross product

$\bar{A}\times\bar{B} = \bar{k}(5z^2x^3 - 2x^4y^2,\ 2x^4z + 2x^3yz^3 - 2x^4y,\ 2x^4y + 2x^3y^2z^2 - 5x^3$

$\bar{C}\times\bar{D} = \bar{k}(xyz^2 - xy^2z,\ x^2yz - xyz^2,\ xy^2z - x^2yz)$

№9

Alternative representations of Ohm's law

1) "I" in the conductor is equal to the potential difference V on the conductor divided by the resistance, or $I = \frac{U}{R}$

2) The potential difference on the conductor is equal to product of the current in the conductor and it's resistance, or $U = I\cdot R$

N 14

What force will 1C repel another 1C repel at the distance of 1m?

$$F = \frac{q_1 \cdot q_2}{4\pi \cdot \varepsilon \cdot r^2} = \frac{1C}{4\pi \cdot 8.85 \cdot 10^{-12} \cdot 1} = 9 \cdot 10^9 \; N$$

$\varepsilon = 8.85 \cdot 10^{-12}$

$r = 1m$

$q_1 = q_2 = 1C$

N 15

What will be the value of electric field causing electric force on a proton being in magnitude to it's weight?

$qE = mg$

$E = \frac{mg}{q}$

$$E = \frac{9.1 \cdot 10^{-31} \cdot 9.8}{1.6 \cdot 10^{-19}} = 55.73 \cdot 10^{-12} = 5.5 \cdot 10^{-12} \frac{N}{C}$$

N 16

A closed surface encapsulates a charge of 10nC. What is the value of the electric flux through the surface?

$$\Phi = \frac{q}{\varepsilon_0} = \frac{10 \cdot 10^{-9}}{8.85 \cdot 10^{-12}} = 1130 \frac{N\,m^2}{C}$$

$\varepsilon_0 = 8.85 \cdot 10^{-12}$

N 18

Current intensity is the rate of flow of electric charge pas a point or region. It is exist when there is a net flow of electric charge through the region. In electronic circuits this charge is often carried by electrons moving through the wire.

List 2

N 12

Solve the e-m wave equation

$$E(x,t) = \nabla^2 E = \mu_0 \varepsilon_0 \frac{\partial^2 E}{\partial t^2}$$

$$E(x,t) = X(x) \cdot T(t)$$

$$E(x,t)_{xx} = X'' \cdot T \qquad E(x,t)_{tt} = X \cdot T''$$

$$X'' T = \mu_0 \varepsilon_0 X T''$$

$$\frac{X''}{X} = \frac{T''}{T} \cdot \mu_0 \varepsilon_0 = -k^2$$

$$X'' = k^2 X \qquad T'' \mu_0 \varepsilon_0 = k^2 T$$

$$X(x) = a \qquad T(t) = b$$

$$E(x,t) = ab$$

$$X'' = k^2 X$$

$$1 X'' + 0X' - k^2 X = 0$$

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{c} \Rightarrow \frac{0 \pm \sqrt{0 - 4(1)(-k^2)}}{2} = \pm k$$

$$X(x) = e^{(\pm k^2 x)} \left[A\cos(x) + B(\sin(x)) \right]$$

$$X(x) = Ae^{(\pm kx)}$$

$$X(x) = C X_1(x) + D X_2(x)$$

$$X(x) = Ae^{kx} + Be^{-kx}$$

$T(t) = C \cdot e^{kvt} + De^{kvt}$

$v = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

$E(x,t) = X(x) \cdot T(t)$

$E(x,t) = Ae^{k(x+vt)} + Be^{k(x-vt)}$

$\nabla^2 E = \mu_0 \varepsilon_0 \frac{\partial^2 E}{\partial t^2}$

$e^{-ax^2} = \int_{-\infty}^{\infty} A(k) \left[S_{\alpha}{}^{n}_{\varepsilon} \right] dk.$

Basis

Fourier Transform

№8

Prove the non-cloning theorem

I $\quad U|\psi\rangle_A |x\rangle_B = e^{i\alpha} |\psi\rangle_A |\psi\rangle_B$ — possible!

II $\quad U|\varphi\rangle_A |x\rangle_B = e^{i\beta} |\varphi\rangle_A |\varphi\rangle_B \Leftrightarrow \langle\varphi|_A \langle x|_B U^{\dagger} = e^{i\beta} \langle\varphi|_A \langle\varphi|_B$

I·II $\quad \langle\varphi|_A \langle x|_B \underline{U^{\dagger} U} |\psi\rangle_A |x\rangle_B = e^{i(\alpha-\beta)} \langle\varphi|_A \langle\varphi|_B |\psi\rangle_A |\psi\rangle_B$

$|\psi\rangle_A \otimes |x\rangle_B$

$|\langle\varphi|\psi\rangle \cdot \langle x|x\rangle| = |\cancel{e^{i(\alpha-\beta)}} \langle\varphi|\psi\rangle \cdot \langle\varphi|\psi\rangle|$ $\quad \| \; \otimes 1$

$|z^2| = |z|^2 \quad x = 1$

$|\langle\varphi|\psi\rangle| = |\langle\varphi|\psi\rangle|^2 \sim x = x^2$

$x = 1 \Rightarrow |\psi\rangle = e^{i\gamma}|\varphi\rangle$

$x = 0 \Rightarrow |\psi\rangle \perp |\varphi\rangle$

Using no-broadcast theorem

$$\rho_A \otimes X_B \neq U(\rho_A \otimes X_B) = \tilde{\rho}_{AB}, \text{ with } Tr_A(\tilde{\rho}) = \rho \text{ and } Tr_B(\tilde{\rho}) = \rho$$

$\nexists$

N14

Show how the quantum negation gate works

The CNOT Gate operates on a quantum register consisting of 2 qubits. The CNOT gate flips the second qubit (the target one) if and only if the first qubit (the control qubit) is $|1\rangle$

Before		After	
Control	Target	Control	Target
$\|0\rangle$	$\|0\rangle$	$\|0\rangle$	$\|0\rangle$
$\|0\rangle$	$\|1\rangle$	$\|0\rangle$	$\|1\rangle$
$\|1\rangle$	$\|0\rangle$	$\|1\rangle$	$\|1\rangle$
$\|1\rangle$	$\|1\rangle$	$\|1\rangle$	$\|0\rangle$

N 19

Describe How QKD protocol works

QKD protocol is a cryptographic protocol involving components of quantum mechanics. It enables two parties to produce a shared ~~[illegible]~~ random secret key known only to them, which ~~[illegible]~~ then can be used to encrypt and decrypt messages. An important and unique property is the ability of the two communicating users to detect the presence of any third party trying to get knowledge of the key