15 – ma’ruza.

Mavzu: O’tkazgichlarni elektr sigimi. Elektr maydon energiyasi

Agar o’tkazgichga biror q zaryad berilsa, u o’tqazgich sirti bo’yicha taqsimlanadi. Yagonalangan o’tqazgichning potensiali undagi zaryadning miqdoriga proporsional:

$$q = c\varphi \qquad (1)$$

Potensial va zaryad o’rtasidan proporsionallik koeffitsiyenti o’tqazgichning elektr sig’imi deyiladi.

$$c = q/\varphi \qquad (2)$$

Radiusi R ga teng bo’lgan zaryadlangan sharning potensiali quyidagicha:

$$\varphi = \frac{1}{4\pi\varepsilon_0}\int_R^\infty \frac{q}{\varepsilon r^2}dr = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q}{\varepsilon r} \qquad (3)$$

(3) va (2) dan sig’im (shar uchun):

$$C = 4\pi\cdot\varepsilon_0\varepsilon R \qquad (4)$$

ga teng.

HB - da c=q/φ=l K/v =1 f (farada):

$$1ф = \frac{1K}{1в} = \frac{3\cdot10^9}{1/300}сгсэ = 9\cdot10^{11}см = 9\cdot10^9 м$$

1 mkf=10^{-6} f, 1 pf=10^{-12} f=0,9 sm

KONDENSATORLAR.

Yagonalangan o’tqazgichning sig’imi kichik. Kichik potensialda ko’p zaryad yig’a oladigan qurilmalar kondensatorlar deyiladi. Kondensator bir-biriga yaqin joylashgan 2 ta o’tqazgich sifatida yasaladi.

Bu o’tqazgichlar kondensator qoplamalari deyiladi. Yassi, silindrsimon va sferik kondensatorlar mavjud.

Kondensatorning sig’imi:

$$c = q/(\varphi_1 - \varphi_2) \qquad (1)$$

Yassi kondensator sig’imini chiqaraylik.

$$E = \frac{\sigma}{\varepsilon_0 \varepsilon} = \frac{q}{\varepsilon_0 \cdot \varepsilon \cdot S} \qquad (2)$$

(2)da potensiallar farqi:

$$\varphi_1 - \varphi_2 = Ed \frac{qd}{\varepsilon_0 \varepsilon S} \qquad (3)$$

(1) va (3) dan: $$c = \frac{\varepsilon_0 \varepsilon S}{d} \qquad (4)$$

S-qoplamlar yuzi, d-qoplamalar orasidagi masofa.

Gauss sistemasida: $c = \frac{\varepsilon S}{4\pi d}$ (5)

Silindrsimon kondensatorning sigimi:

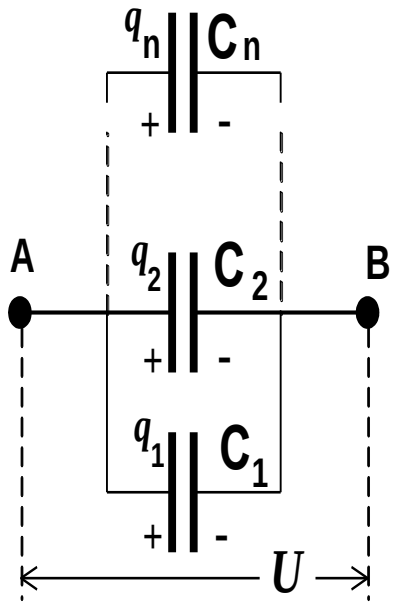
$$c = \frac{2\pi\varepsilon_0 \varepsilon /}{In\frac{R_2}{R_1}} \qquad (6)$$

R_1 va R_2 - ichki va tashqi qoplamalar radiuslari, 1-qoplamalar uzunligi.
Sferik kondensatorning sig'imi:

$$c = 4\pi\varepsilon_0 \cdot \varepsilon \frac{R_1 R_2}{R_2 - R_1} \qquad (7)$$

KONDENSATORLARNI ULASh.

Kondensatorlarning ikki xil ulanishi bilan tanishamiz.



8 - chizma

Paralell ulanganda har bir kondensatorning qoplamalari φ_1 va φ_2 potensialga ega bo'ladi (8-chizma):

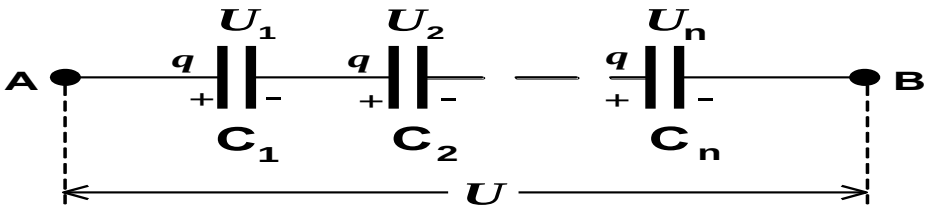
$$q = \sum q_k = \sum c_k(\varphi_1 - \varphi_2) = (\varphi_1 - \varphi_2)\sum c_k \qquad (1)$$

(1)ga teng zaryad to'planadi.

Agar zaryad batareyaga ulangan kuchlanishga taqsimlasak, batareyaning sig'imini topamiz.

$$c = \sum c_k \qquad (2)$$

Kondensatorlarni ketma-ket ulash quyidagicha



9 – chizma

Har bir kondensatordagi kuchlanish:

$$U_k = q / c_k \tag{3}$$

Bu kuchlanishlar yigindisi batareyaga potensiallar ayirmasiga teng:

$$\varphi_1 - \varphi_2 = \sum U_k = \sum q / c_k = q \sum 1 / c_k \tag{4}$$

Bu yerdan

$$1 / c = \sum 1 / c_k \tag{5}$$

bo'ladi.

Kendensatorlar ketma-ket ulanganda sig'imlariga teskari kattaliklar qo'yiladi. Agar kondensatorlar bir xil bo'lib, sig'imlari C_1 ga va chegaraviy kuchlanishlari U_{max} ga teng bo'lsa, ketma-ket ulanganda $c = \frac{1}{N} C_1$, U_{max}=N U_{max} ga teng bo'ladi.

ELEKTR MAYDON ENERGIYaSI ZARYaDLANGAN SISTEMASINING ENERGIYaSI.

Cheksizlikdan o'tqazgichdagi q_1 zaryadni q_2 dan g_{12} masofaga ko'chirishda bajarilgan ish:

$$A_1 = q_1 \varphi_1 = q_1 \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_2}{r_{12}} \tag{1}$$

Xuddi shuningdek, q_2 zaryadni cheksizlikdan q_1 dan g_{12} masofaga siljitishda bajarilgan ish:

$$A_2 = q_2 \varphi_2 = q_2 \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1}{r_{12}} \tag{2}$$

(1) va (2) dan sistemaning energiyasi:

$$W = q_1 \varphi_1 = q_2 \varphi_2 \tag{3}$$

Zaryadlar N bo'lsa, sistemaning potensial energiyasi:

$$W = \frac{1}{2} \sum q_i \varphi_i \tag{4}$$

bo'ladi.

ZARYaDLANGAN O’TQAZGIChNING ENERGIYaSI.

Biror o’tqazgichdagi Δq nuqtaviy zaryadni kuchirishda bajarilgan ish:

$$\Delta A = \varphi \Delta q = q \Delta q / c \qquad (1)$$

Bu vaqtda o’tqazgichning energiya orttirmasi (differensial ko’rinishda):

$$dW=qdq/c \qquad (2)$$

(2) dan energiya orttirmasi:

$$W=q^2/2c+const \qquad (3)$$

const=0.

$$W = \frac{q^2}{2c} = \frac{q\varphi}{2} = \frac{c\varphi^2}{2} \qquad (4)$$

(4) formulami Δq zaryadlarning sistemasiga qo’llasak:

$$W = \frac{1}{2}\sum \varphi \Delta q = \frac{1}{2}\sum \Delta q = \frac{1}{2}\varphi q \qquad (5)$$

bo’ldi.

ZARYaDLANGAN KONDESATORNING ENERGIYaSI.

Kondensatorning bir qoplamasidan ikkinchi qoplamasiga Δq porsiyami ko’chirishda bajarilgan ish:

$$\Delta A = \Delta q(\varphi_1 - \varphi_2) = \Delta q U \qquad (1)$$

$$dW = dA = Udq = qdq / c \qquad (2)$$

(2) energiyaning differensial orqali ifodasi (2) integrallasak:

$$W = \frac{q^2}{2c} = \frac{qU}{2} = \frac{cU^2}{2} \qquad (3)$$

ELEKTR MAYDONING ENERGIYaSI.

Yuqoridagi kondensatorning energiyasi va sig’im formulasidan foydalanib quyidagini hosil qilamiz:

$$W = \frac{CU^2}{2} = \frac{\varepsilon_0 \varepsilon S U^2}{2d} = \frac{\varepsilon_0 \varepsilon}{2}\left(\frac{U}{d}\right)^2 Sd \qquad (1)$$

U/d=E ga teng. Sd- ko’paytma maydon egallagan hajmi:

$$W = \frac{\varepsilon \varepsilon E^2}{2} \cdot V \qquad (2)$$

(2) dan yassi kondensator maydon energiyasining zichligi:

$$W = \frac{\varepsilon \varepsilon E^2}{2} \qquad (3)$$

kelib chiqadi.

Elektr maydon energiyasi zichligi Gauss sistemasida:

$$W = \frac{\varepsilon E^2}{8\pi} = \frac{ED}{8\pi} = \frac{D^2}{8\varepsilon\pi} \qquad (4)$$