NAMUNAVIY MASALALAR

1-masala

Ikki yoriqli tajribada yoriqlar orasidagi masofa d = 0,25 mm, ekran yoriqlardan L = 2,00 m uzoqlikda. Yorug‘lik to‘lqin uzunligi λ = 600 nm. Markazdan hisoblab m = 4-tartibli yorug‘ tasmaning ekrandagi siljishini toping.

Yechim: Yung formulasi:
$x = m \cdot \lambda \cdot \frac{L}{d}$.

Birinchi birliklarni metrga o‘tkazamiz:

$$d = 0{,}25\,mm = 2{,}50 \cdot 10^{-4}\,m, \lambda = 600\,nm = 6{,}00 \cdot 10^{-7}\,m.$$

$$x = 4 \cdot 6{,}00 \cdot 10^{-7} \cdot 2{,}00/2{,}50 \cdot 10^{-4}.$$

Yuqori qismi: $4 \cdot 6{,}00 \cdot 10^{-7} \cdot 2{,}00 = 4 \cdot 1{,}20 \cdot 10^{-6} = 4{,}80 \cdot 10^{-6}$.
Bo‘luvchi: $2{,}50 \cdot 10^{-4}$.

$$x = 4{,}80 \cdot 10^{-6}/2{,}50 \cdot 10^{-4} = (4{,}80/2{,}50) \cdot 10^{-2} = 1{,}92 \cdot 10^{-2}\,m = 0{,}0192\,m = 19{,}2\,mm.$$

Javob: 19,2 mm.

2-masala — Tasma oralig‘i Δx

$L = 1{,}50\,m, d = 0{,}40\,mm, \lambda = 500\,nm$. Ikki yoriqli interferensiyada tasma oralig‘i $\Delta x = ?$

Yechim: $\Delta x = \lambda \cdot L/d$.

Birliklar: $d = 0{,}40\,mm = 4{,}00 \cdot 10^{-4}\,m, \lambda = 500\,nm = 5{,}00 \cdot 10^{-7}\,m$.

$$\Delta x = 5{,}00 \cdot 10^{-7} \cdot 1{,}50/4{,}00 \cdot 10^{-4} = 7{,}50 \cdot 10^{-7}/4{,}00 \cdot 10^{-4}.$$

$$7{,}50 \cdot 10^{-7}/4{,}00 \cdot 10^{-4} = (7{,}50/4{,}00) \cdot 10^{-3} = 1{,}875 \cdot 10^{-3}\,m = 1{,}875\,mm.$$

Javob: 1,875 mm.

3-masala — Ekran chetida nechta yorug‘ tasma ko‘rinadi?

$d = 0{,}20\,mm, L = 1{,}00\,m, \lambda = 550\,nm$. Ekranda markazdan ±0,10 m gacha (ya’ni har tomonga 0,10 m) joyni hisobga olib, nechta yorug‘ maksimum (butun jami) ko‘rinishini toping.

Yechim: Maksimumlarning o‘rni $x = m \cdot \lambda \cdot L/d$. Chegara sharti: $|x| \leq 0{,}10\,m \rightarrow m$ maksimal:

$$m_{\max} \leq 0{,}10 \cdot d/(\lambda \cdot L).$$

$d = 0{,}20\,mm = 2{,}00 \cdot 10^{-4}\,m;\ \lambda = 550\,nm = 5{,}50 \cdot 10^{-7}\,m;\ L = 1{,}00\,m.$

$m_{max} \leq 0{,}10 \cdot 2{,}00 \cdot 10^{-4}/(5{,}50 \cdot 10^{-7} \cdot 1{,}00) = 2{,}00 \cdot 10^{-5}/5{,}50 \cdot 10^{-7}.$

$2{,}00 \cdot 10^{-5}/5{,}50 \cdot 10^{-7} = (2{,}00/5{,}50) \cdot 10^{2} \approx 0{,}363636 \cdot 100 = 36{,}3636.$

But m butun son: $m_{max} = 36$. Demak musbat va manfiy $m = -36$ ... $+36$ hamda $m = 0$: jami N = 2·36 + 1 = 73 maksimum.

Javob: 73 ta.

4-masala

Sovun pufagi $n = 1{,}33$ ga ega; yorug‘lik $\lambda = 550\,nm$ havoda tik tushmoqda. Aks etgan nur uchun eng kichik pufagi qalinligini toping (konstruktiv reflektiv interferensiya).

Yechim: Havo → pufak (n ortadi) bo‘lgani uchun yuqori sirtda π faza siljishi, pastki sirtda (pufakdan havo) faza siljishi yo‘q. Bitta faza yoki to‘liq bir faza farqi natijasida reflektiv konstruktiv shart:

$2 \cdot n \cdot d = (m + 1/2) \cdot \lambda.$

Eng kichik d uchun $m = 0$:

$$d = \lambda/(4 \cdot n).$$

$\lambda = 550 \cdot 10^{-9}\,m, n = 1{,}33$:

$$d = 550 \cdot 10^{-9}/(4 \cdot 1{,}33) = 550 \cdot 10^{-9}/5{,}32 \approx 103{,}38 \cdot 10^{-9}\,m \approx 1{,}03 \cdot 10^{-}7\,m = 103\,nm.$$

Javob: ≈ 103 nm.

5-masala — Bir yoriq difraksiyasi: birinchi minimum burchagi va markaziy maksimum kengligi

Yoriq kengligi $b = 0{,}20\,mm$, yorug‘lik $\lambda = 632{,}8\,nm$ (He-Ne). Ekran yoriqdan $L = 1{,}50\,m$ uzoqda. Toping: a) birinchi minimum burchagi $(\theta_1;\ b)$ markaziy maksimumning ekrandagi to‘liq kengligi Δx.

Yechim:
a) Minimum sharti: $b \cdot sin\theta = m \cdot \lambda$, birinchi minimum $m = 1 \rightarrow sin\theta_1 = \lambda/b$.

$$b = 0{,}20\,mm = 2{,}00 \cdot 10^{-4}\,m;\ \lambda = 632{,}8\,nm = 6{,}328 \cdot 10^{-7}\,m.$$

$$sin\theta_1 = 6{,}328 \cdot 10^{-7}/2{,}00 \cdot 10^{-4} = 3{,}164 \cdot 10^{-3}.$$

$$\theta_1 \approx 3{,}164 \cdot 10^{-3}\,rad \approx 0{,}1813°.$$

b) Markaziy maksimum to‘liq kengligi (kichik burchaklarda): $\Delta x = 2 \cdot L \cdot tan\theta_1 \approx 2 \cdot L \cdot \theta_1$ (θ in rad).

$$\theta_1 \approx 3{,}164 \cdot 10^{-3}\,rad;\ L = 1{,}50\,m.$$

$$\Delta x \approx 2 \cdot 1{,}50 \cdot 3{,}164 \cdot 10^{-3} = 3{,}00 \cdot 3{,}164 \cdot 10^{-3} = 9{,}492 \cdot 10^{-3}\,m = 9{,}49\,mm.$$

Javob: a) $\theta_1 \approx 0{,}003164\,rad$ (≈ 0,181°); b) $\Delta x \approx 9{,}49\,mm$.

6-masala — Diffraksion panjara: $m = 2$ burchagi

Panjarada 600 chiziq 1 mm ga tushirilgan (ya’ni N = 600 per mm). Monoxromatik $\lambda = 450\,nm$. Toping: m = 2 tartibdagi maksimumning burchagi θ_2.

Yechim: Panjara doimiysi $d = 1\,mm/600 = (1 \cdot 10^{-3})/600 = 1{,}6666667 \cdot 10^{-6}\,m = 1{,}6667 \cdot 10^{-6}\,m$.

Shart: $d \cdot sin\theta = m \cdot \lambda \rightarrow sin\theta_2 = 2 \cdot \lambda/d = 2 \cdot 450 \cdot 10^{-9}/1{,}6667 \cdot 10^{-6}$.

$900 \cdot 10^{-9} = 9{,}00 \cdot 10^{-}7. Divide$: $9{,}00 \cdot 10^{-}7/1{,}6667 \cdot 10^{-}6 = (9{,}00/1{,}6667) \cdot 10^{-}(7-6) = 5{,}4 \cdot 10^{-}1 = 0{,}54$.

$sin\theta_2 = 0{,}54 \rightarrow \theta_2 \approx arcsin(0{,}54) \approx 32{,}7°$.

Javob: $\theta_2 \approx 32{,}7°$.

7-masala — Panjarada ikki rang orasidagi burchak farqi (m = 1)

Bir panjarada $d = 2{,}50 \cdot 10^{-6}\,m. \lambda_1 = 480\,nm, \lambda_2 = 650\,nm. m = 1$ uchun ikki rangning burchak farqini toping.

Yechim: $sin\theta = m \cdot \lambda/d$.

$sin\theta_1 = 480 \cdot 10^{-9}/2{,}50 \cdot 10^{-6} = 0{,}192 \rightarrow \theta_1 \approx arcsin(0{,}192) \approx 11{,}06°$.
$sin\theta_2 = 650 \cdot 10^{-9}/2{,}50 \cdot 10^{-6} = 0{,}26 \rightarrow \theta_2 \approx arcsin(0{,}26) \approx 15{,}09°$.

$$\Delta\theta = \theta_2 - \theta_1 \approx 15{,}09° - 11{,}06° = 4{,}03° (\approx 0{,}0704\, rad).$$

Javob: $\approx 4{,}03°$ ($\approx 0{,}070$ rad).

8-masala — Malyus qonuni amaliyoti

Qutblanmagan yorug‘lik $I_0 = 10{,}0\ W/m^2$ polarizatordan o‘tadi, so‘ng analisator $\alpha = 50°$ burchak bilan joylashgan. Analizator chiqishidagi intensivlik I ni toping.

Yechim: Qutblanmagan → polarizatordan keyin $I_1 = I_0/2 = 5{,}00\ W/m^2$.
Keyin Malyus qonuni: $I = I_1 \cdot cos^2\alpha$.

$$cos50° \approx 0{,}6428 \rightarrow cos^2 50° \approx 0{,}4132.$$

$$I = 5{,}00 \cdot 0{,}4132 = 2{,}066\ W/m^2 \approx 2{,}07\ W/m^2.$$

Javob: $\approx 2{,}07\ W/m^2$.

9-masala — Brevster burchagi

Havo ($n_1 = 1{,}00$) va shisha ($n_2 = 1{,}50$). Brewster burchagini θ_β toping va shu burchakda aks etgan nurning qutblanish holatini yozing.

Yechim: $tg\theta_\beta = n_2/n_1 = 1{,}50/1{,}00 = 1{,}50$.
$\theta_\beta = arctg(1{,}50) \approx 56{,}31°$.

Brewster burchagida aks etgan nur to‘liq chiziqli qutblangan bo‘ladi (E vektori yuzaga parallel bo‘lgan komponent o‘chadi).

Javob: $\theta_\beta \approx 56{,}3°$; aks etgan nur chiziqli qutblangan.

10-masala — Suv ostida ikki yoriq: tasma oralig‘i

Ikki yoriq $d = 0{,}50\ mm$, ekran $L = 2{,}00\ m$, yorug‘lik havoda $\lambda = 600\ nm$, lekin tajriba suyuqlik bilan to‘ldirilgan (n = 1,33). Suv ichida tasma oralig‘i Δx ni toping.

Yechim: Suyuqlik ichida to‘lqin uzunligi $\lambda' = \lambda/n = 600 \cdot 10^{-9}/1{,}33 \approx 4{,}5113 \cdot 10^{-7}\ m$.

$$\Delta x = \lambda' \cdot L/d.$$

$$d = 0{,}50\ mm = 5{,}00 \cdot 10^{-4}\ m.$$

$$\Delta x = 4{,}5113 \cdot 10^{-7} \cdot 2{,}00/5{,}00 \cdot 10^{-4} = 9{,}0226 \cdot 10^{-7}/5{,}00 \cdot 10^{-4} = (9{,}0226/5{,}00) \cdot 10^{-3} = 1{,}80452 \cdot 10^{-3}\ m = 1{,}8045\ mm.$$

Javob: ≈ 1,8045 mm.