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Devices with Optical Components Formulas

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List of 14 Devices with Optical Components Formulas

Devices with Optical Components

1) Angle of Rotation of Plane of Polarization

Open Calculator

fx $\theta = 1.8 \cdot B \cdot L_m$

ex $19.53\text{rad} = 1.8 \cdot 0.35\text{T} \cdot 31\text{m}$

2) Apex Angle

Open Calculator

fx $A = \tan(\alpha)$

ex $8.167315^\circ = \tan(-3)$

3) Brewsters Angle

Open Calculator

fx $\theta_B = \arctan\left(\frac{n_1}{n_{ri}}\right)$

ex $56.0463^\circ = \arctan\left(\frac{1.5}{1.01}\right)$

4) Current Due to Optically Generated Carrier

Open Calculator

fx $i_{opt} = q \cdot A_{pn} \cdot g_{op} \cdot (W + L_{dif} + L_p)$

ex $0.6\text{mA} = 0.3\text{C} \cdot 4.8\mu\text{m}^2 \cdot 2.9\text{e}13 \cdot (6.79\mu\text{m} + 5.477816\mu\text{m} + 2.1\mu\text{m})$

5) Diffraction using Fresnel-Kirchoff Formula

Open Calculator

fx $\theta_{dif} = a\sin\left(1.22 \cdot \frac{\lambda_{vis}}{D}\right)$

ex $0.0061\text{rad} = a\sin\left(1.22 \cdot \frac{500\text{nm}}{0.1\text{mm}}\right)$

6) Diffusion Coefficient of Electron

Open Calculator

$$D_E = \mu_e \cdot [BoltZ] \cdot \frac{T}{[Charge\text{-}e]}$$

$$0.003387 m^2/s = 1000 cm^2/V*s \cdot [BoltZ] \cdot \frac{393K}{[Charge\text{-}e]}$$

7) Diffusion Length of Transition Region

Open Calculator

$$L_{dif} = \frac{i_{opt}}{q \cdot A_{pn} \cdot g_{op}} - (W + L_p)$$

$$5.477816\mu m = \frac{0.60mA}{0.3C \cdot 4.8\mu m^2 \cdot 2.9e13} - (6.79\mu m + 2.1\mu m)$$

8) Effective Density of States in Conduction Band

Open Calculator

$$N_{eff} = 2 \cdot \left(2 \cdot \pi \cdot m_{eff} \cdot [BoltZ] \cdot \frac{T}{[hP]^2}\right)^{\frac{3}{2}}$$

$$3.9E\hat{}24 = 2 \cdot \left(2 \cdot \pi \cdot 0.2e\text{-}30kg \cdot [BoltZ] \cdot \frac{393K}{[hP]^2}\right)^{\frac{3}{2}}$$

9) Electron Concentration under Unbalanced Condition

Open Calculator

$$n_e = n_i \cdot \exp\left(\frac{F_n - E_i}{[BoltZ] \cdot T}\right)$$

$$0.339151 electrons/m^3 = 3.6 electrons/m^3 \cdot \exp\left(\frac{3.7eV - 3.78eV}{[BoltZ] \cdot 393K}\right)$$

10) Excitation Energy

Open Calculator

$$E_{exc} = 1.6 \cdot 10^{-19} \cdot 13.6 \cdot \left(\frac{m_{eff}}{[Mass\text{-}e]}\right) \cdot \left(\frac{1}{[Permitivity\text{-}silicon]^2}\right)$$

$$0.021783eV = 1.6 \cdot 10^{-19} \cdot 13.6 \cdot \left(\frac{0.2e\text{-}30kg}{[Mass\text{-}e]}\right) \cdot \left(\frac{1}{[Permitivity\text{-}silicon]^2}\right)$$

11) Fringe Spacing given Apex Angle

Open Calculator

fx $$S_{fri} = \frac{\lambda_{vis}}{2 \cdot \tan\left(\alpha_{opto}\right)}$$

ex $$1.41782\mu = \frac{500nm}{2 \cdot \tan(10^\circ)}$$

12) Maximum Acceptance Angle of Compound Lens

Open Calculator

fx $$\theta_{acc} = a\sin\left(n_1 \cdot R_{lens} \cdot \sqrt{A_{con}}\right)$$

ex $$22.02431^\circ = a\sin\left(1.5 \cdot 0.0025m \cdot \sqrt{10000}\right)$$

13) Peak Retardation

Open Calculator

fx $$\Phi_m = \frac{2 \cdot \pi}{\lambda_o} \cdot r \cdot n_{ri}^3 \cdot V_m$$

ex $$80.1349rad = \frac{2 \cdot \pi}{3.939m} \cdot 23m \cdot (1.01)^3 \cdot 2.12V$$

14) PN Junction Capacitance

Open Calculator

fx $$C_j = \frac{A_{pn}}{2} \cdot \sqrt{\frac{2 \cdot [Charge\text{-}e] \cdot \varepsilon_r \cdot [Permitivity\text{-}silicon]}{V_0 - (V)} \cdot \left(\frac{N_A \cdot N_D}{N_A + N_D}\right)}$$

ex $$1.9E\hat{}6fF = \frac{4.8\mu m^2}{2} \cdot \sqrt{\frac{2 \cdot [Charge\text{-}e] \cdot 78F/m \cdot [Permitivity\text{-}silicon]}{0.6V - (-4V)} \cdot \left(\frac{1e{+}22/m^3 \cdot 1e{+}24/m^3}{1e{+}22/m^3 + 1e{+}24/m^3}\right)}$$

Variables Used

- **A** Apex Angle *(Degree)*
- A_{con} Positive Constant
- A_{pn} PN Junction Area *(Square Micrometer)*
- **B** Magnetic Flux Density *(Tesla)*
- C_j Junction Capacitance *(Femtofarad)*
- **D** Diameter of Aperture *(Millimeter)*
- D_E Electron Diffusion Coefficient *(Square Meter Per Second)*
- E_{exc} Excitation Energy *(Electron-Volt)*
- E_i Intrinsic Energy Level of Semiconductor *(Electron-Volt)*
- F_n Quasi Fermi Level of Electrons *(Electron-Volt)*
- g_{op} Optical Generation Rate
- i_{opt} Optical Current *(Milliampere)*
- L_{dif} Diffusion Length of Transition Region *(Micrometer)*
- L_m Length of Medium *(Meter)*
- L_p Length of P-Side Junction *(Micrometer)*
- m_{eff} Effective Mass of Electron *(Kilogram)*
- n_1 Refractive Index of Medium 1
- N_A Acceptor Concentration *(1 per Cubic Meter)*
- N_D Donor Concentration *(1 per Cubic Meter)*
- n_e Electron Concentration *(Electrons per Cubic Meter)*
- N_{eff} Effective Density of States
- n_i Intrinsic Electron Concentration *(Electrons per Cubic Meter)*
- n_{ri} Refractive Index
- **q** Charge *(Coulomb)*
- **r** Length of Fiber *(Meter)*
- R_{lens} Radius of Lens *(Meter)*
- S_{fri} Fringe Space *(Micron)*
- **T** Absolute Temperature *(Kelvin)*
- **V** Reverse Bias Voltage *(Volt)*
- V_0 Voltage Across PN Junction *(Volt)*

- V_m Modulation Voltage *(Volt)*
- W Transition Width *(Micrometer)*
- α Alpha
- α_{opto} Angle of Interference *(Degree)*
- ε_r Relative Permittivity *(Farad per Meter)*
- θ Angle of Rotation *(Radian)*
- θ_{acc} Acceptance Angle *(Degree)*
- θ_B Brewster's Angle *(Degree)*
- θ_{dif} Diffraction Angle *(Radian)*
- λ_o Wavelength of Light *(Meter)*
- λ_{vis} Wavelength of Visible Light *(Nanometer)*
- μ_e Mobility of Electron *(Square Centimeter per Volt Second)*
- Φ_m Peak Retardation *(Radian)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[BoltZ]**, 1.38064852E-23
  Boltzmann constant
- Constant: **[Charge-e]**, 1.60217662E-19
  Charge of electron
- Constant: **[Mass-e]**, 9.10938356E-31
  Mass of electron
- Constant: **[Permitivity-silicon]**, 11.7
  Permittivity of silicon
- Constant: **[hP]**, 6.626070040E-34
  Planck constant
- Function: **arctan**, arctan(Number)
  Inverse trigonometric functions are usually accompanied by the prefix - arc. Mathematically, we represent arctan or the inverse tangent function as tan-1 x or arctan(x).
- Function: **asin**, asin(Number)
  The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.
- Function: **ctan**, ctan(Angle)
  Cotangent is a trigonometric function that is defined as the ratio of the adjacent side to the opposite side in a right triangle.
- Function: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Function: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Function: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: **Length** in Meter (m), Micrometer (µm), Nanometer (nm), Millimeter (mm), Micron (µ)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion

- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Micrometer (µm²)
  Area Unit Conversion
- Measurement: **Energy** in Electron-Volt (eV)
  Energy Unit Conversion
- Measurement: **Electric Charge** in Coulomb (C)
  Electric Charge Unit Conversion
- Measurement: **Angle** in Radian (rad), Degree (°)
  Angle Unit Conversion
- Measurement: **Capacitance** in Femtofarad (fF)
  Capacitance Unit Conversion
- Measurement: **Magnetic Flux Density** in Tesla (T)
  Magnetic Flux Density Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Diffusivity** in Square Meter Per Second (m²/s)
  Diffusivity Unit Conversion
- Measurement: **Mobility** in Square Centimeter per Volt Second (cm²/V*s)
  Mobility Unit Conversion
- Measurement: **Carrier Concentration** in 1 per Cubic Meter (1/m³)
  Carrier Concentration Unit Conversion
- Measurement: **Permittivity** in Farad per Meter (F/m)
  Permittivity Unit Conversion
- Measurement: **Electron Density** in Electrons per Cubic Meter (electrons/m³)
  Electron Density Unit Conversion

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