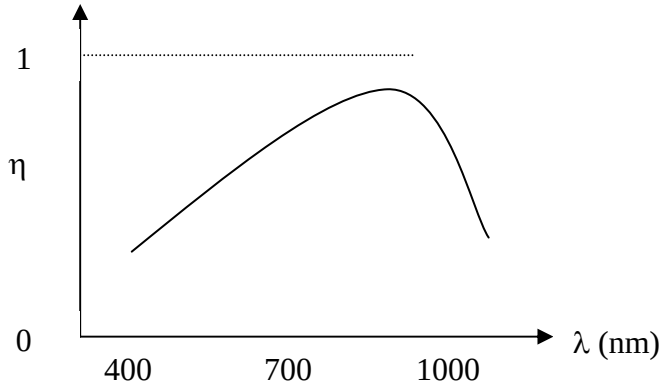
SEMICONDUCTOR OPTOELECTRONICS
Questions & Problems for Revision

PART-IV: Semiconductor Photodetectors

Note: The bold numbers in brackets indicate typical marks allocated to the question in a one-hour written test for 25 marks (or 2 hr written-test for 50 marks)

1. What is meant by *quantum efficiency* of a semiconductor photodetector? What are the measures employed to maximize the quantum efficiency of a photodetector? Figure below shows the spectral dependence of the quantum efficiency of a Si photodiode. Explain briefly the nature of the curve. **(4)**

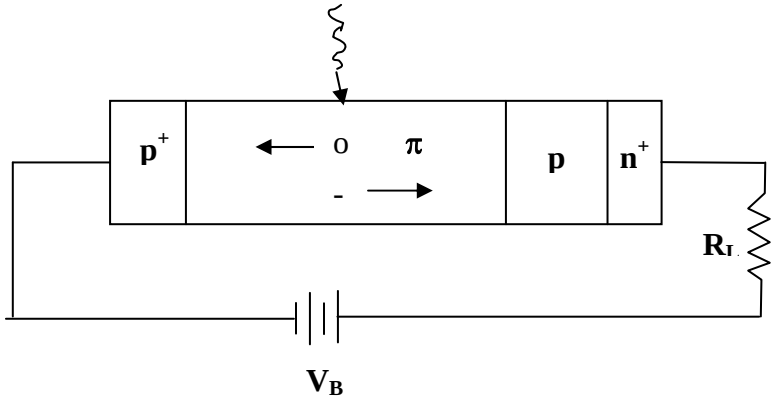


2. Consider a photoconductor of length 1mm, the two ends of which are connected to a biasing supply. At $t = 0$, an instantaneous burst of 10^9 photons, which are distributed uniformly over the entire length of the photoconductor, is incident on it. If the quantum efficiency of the photoconductor is 0.8, and the velocity of electrons in the medium is 10^6 cm/s, determine the photocurrent in the external circuit, and plot it as a function of time. Given: The electron- and hole mobilities in the photoconductor are, respectively, 2000 cm^2/V.s and 1000 cm^2/V.s. (You may assume that the carriers move with uniform velocities). **(5)**

3. What are *photovoltaic* and *photoconductive* modes of operation of a photodiode? Draw the typical I-V characteristics of a photodiode for two different values of incident photon flux; for a given load resistance R_L, show the load lines corresponding to the above two modes of operation. **(4)**

4. Draw typical *i-V* characteristics of a photodiode for 3 different power levels (say, 0, 50 and 100 μW) of the incident radiation. If the photodiode is operated in the *photoconductive* mode of operation, with a bias supply of 10V and a load resistance of 200 kΩ, draw the corresponding load line. (Mark the points of intersection with the *x*- and *y*- axes). Explain briefly the importance of the choice of load resistance in the detector circuit for a given application. **(2+2+2)**

5. Figure shows the structure of a silicon *reach-through* APD. Given that the ratio of the impact ionization coefficients α_e / α_h is much greater than unity (say, 25) at the operating voltage V_B, when the corresponding peak electric field is ~ 10^5 V/cm.



(a) Draw qualitatively the variation of the electric field (in the direction of the applied field) and the potential energy of electrons along the detector medium, and explain briefly the mechanism of operation of the device. **(4)**

(b) Give 2 important reasons (explaining briefly) for using such a structure in the fabrication of the APD. **(2)**