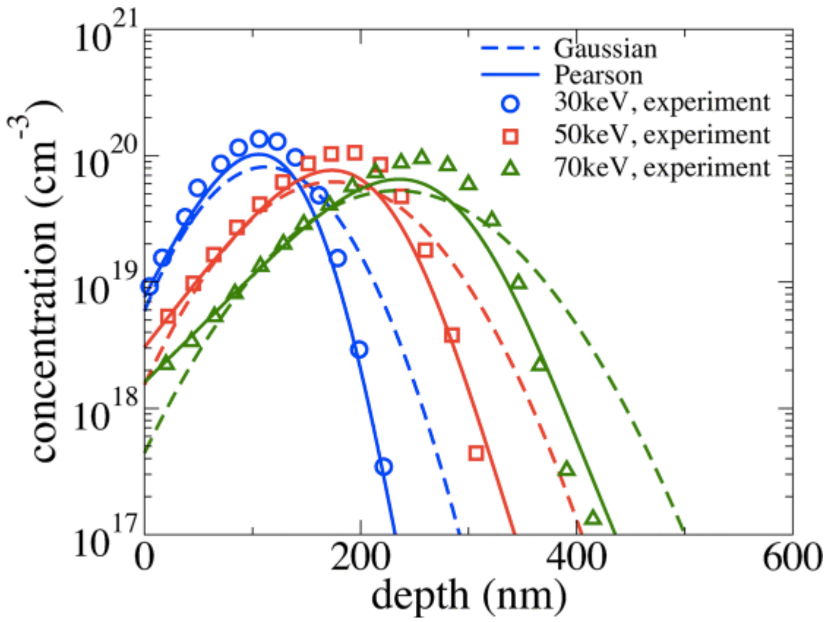
Answer all the questions neatly.
Each question carries 10 marks Time: 120 minutes

Q1. The figure shows a comparison of Pearson model, Gaussian model, and experimental data for a Boron distribution in amorphous silicon by implanting B^+ ions with dose of 10^{15} cm^{-2} at energies of 30, 50, and 70 keV, respectively. Explain what makes Pearson model more accurate as compared to the Gaussian model by giving persuasive explanations.

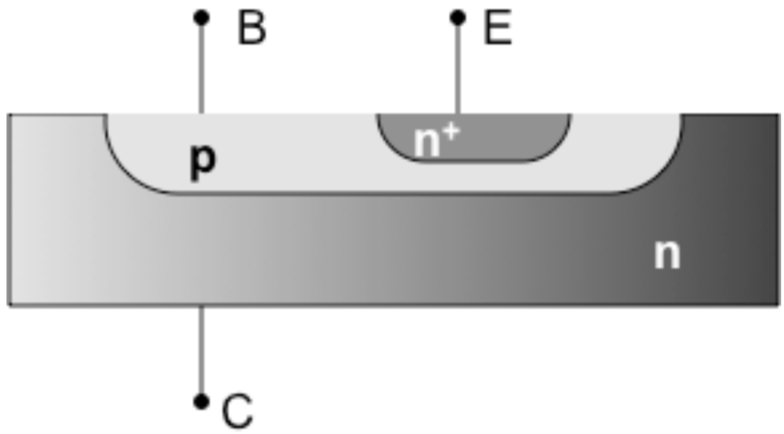


Q2. Conventional ion implantation has certain disadvantages such as the beam size being smaller than the wafer size and therefore necessitates mechanical and electrostatic scanning to achieve dose uniformity, line of cite implantation making it difficult to implant 3-D structures such as Fin FETs and low energy implantation, which is required for shallow junctions, is limited by ion beam optics.

(a) Please discuss if there is an alternate implantation process to overcome the above limitations of conventional ion implantation process. How does this process work? Explain its principles of operation using a diagram; and

(b) You should also highlight if there are any disadvantages of such an alternate implantation method, if it exists.

Q3. Design a thermal diffusion recipe for realizing a bipolar transistor as shown below. Assume that the collector doping is $N_D = 10^{15}/cm^3$. If the last digit in your entry number is an odd number, both the emitter-base junction depth and the base width should be odd. If the last digit in your entry number is an even number, both the emitter-base junction depth and the base width should be even. If the last digit in your entry number is zero, the emitter-base junction depth should be odd and the base width should be even. Choose appropriate pre-deposition and drive-in temperatures. Choose the dopants of your choice. No need to draw the fabrication steps.



Q4. Resolution in optical lithography can be described using the modified Rayleigh criterion:

$$R = k_1 \frac{\lambda}{NA}$$

where k_1 is a constant. Assuming $k_1 = 0.35$, plot resolution versus numerical aperture NA over a range of NAs from 0.5 to 1.0 for the common lithographic wavelengths λ of 436, 365, 248, 193 and 157 nm. From this plot, find what options (NA and wavelength) are available for printing 90-nm features?

Q5. A process engineer has access to a 64 nm half-pitch lithography facility. But using this facility, the process engineer has to realize a 32 nm half-pitch array. Describe how this can be achieved using appropriate neatly drawn figures.