

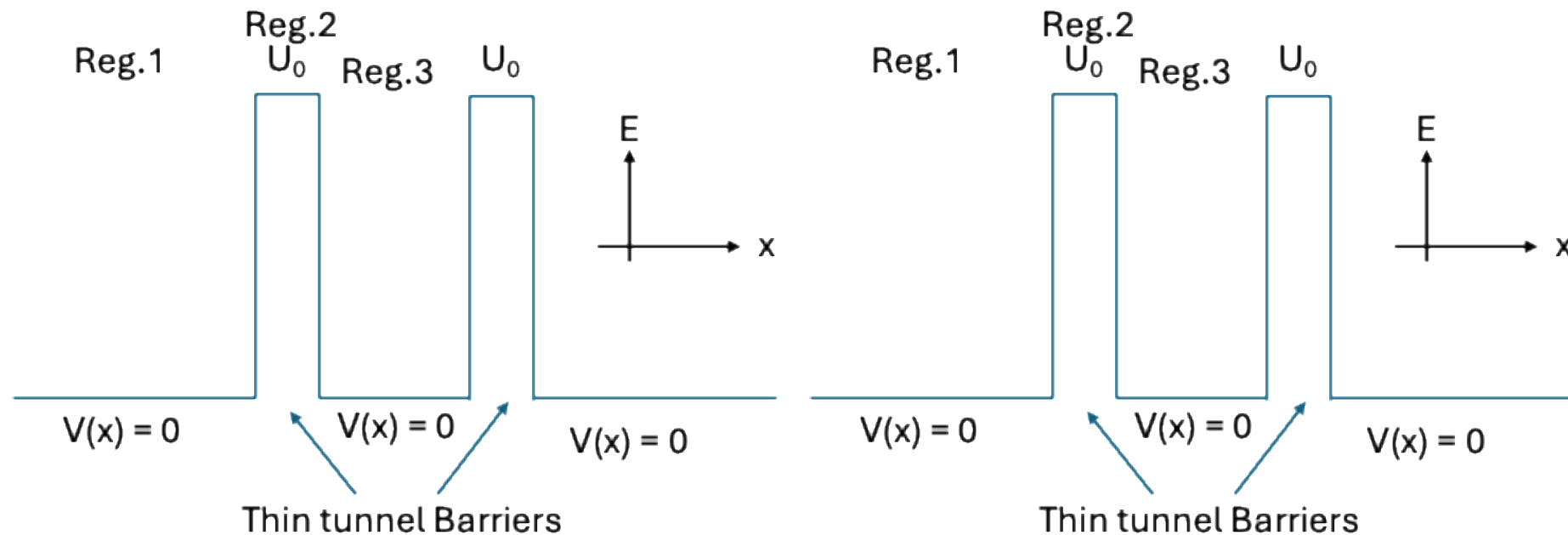
Class Test 1-4 Consolidated

EE1204 (2025)

Class Test-1 (Quantum Mechanics)

Below is a double tunnel barrier structure used in Resonant Tunnel Diodes. The region b/w the thin tunnel barriers [Reg.3] is where resonance occurs (formation of standing wave).

(a) Write the most intuitive functional form of the wave equation in Reg.1, Reg. 2 and Reg. 3 [2]



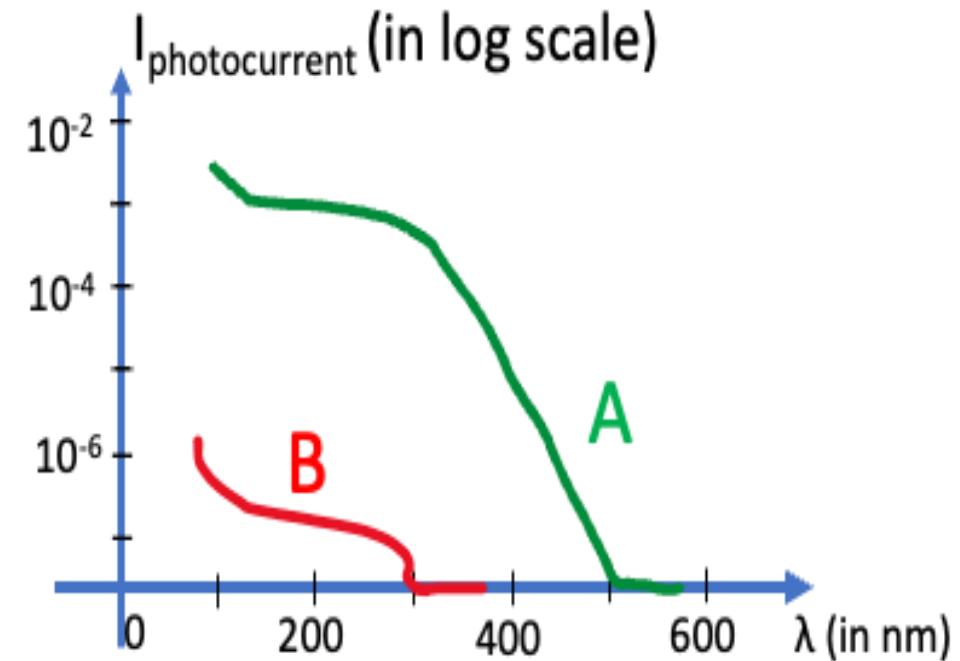
Draw first mode below:

Draw second mode below:

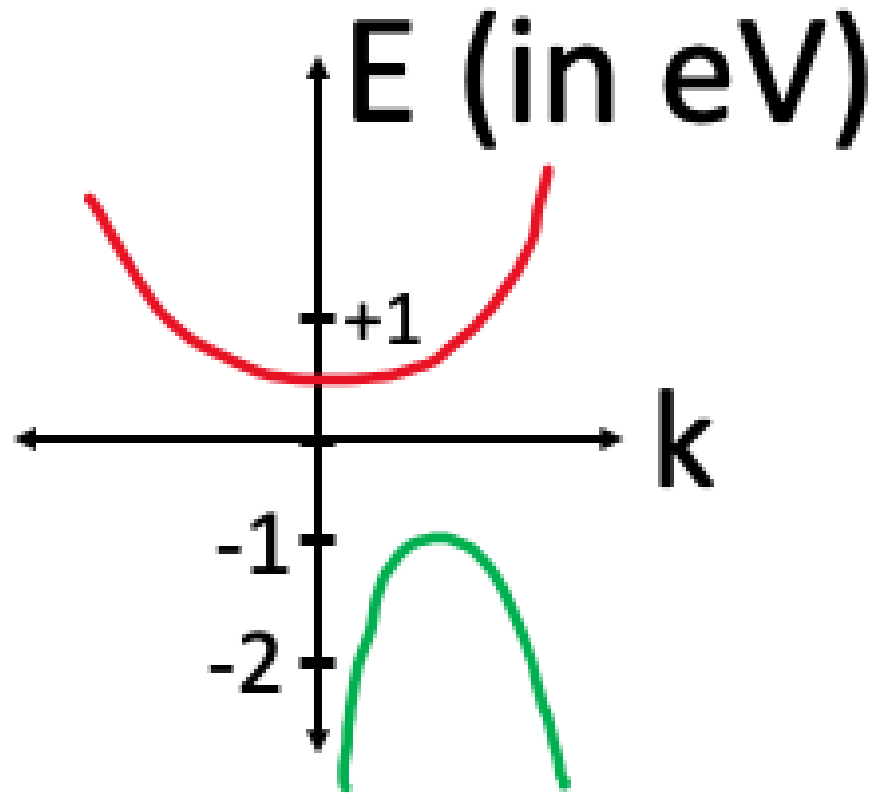
(b) Draw the wavefunction (on the graphs) for the first two modes of resonant condition for all 'x'. [3]

Class Test-2 (Band Theory)

Consider Semiconductor A and B with same doping and lattice constant(a). Both A and B have an electron mobility of $1000 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$, whereas the hole mobility of A is $250 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$ that of B is $500 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$. The graph demonstrates the current obtained for both materials as a function of wavelength of light shining on the two materials. It is known that one of the semiconductors is direct whereas other is indirect – with momentum transfer $+\pi/2a$ from valence band to conduction band transitions. Draw a semiquantitative band structure for both A and B in the first Brillouin zone. Consider the conduction band minima to be the reference ($E_{\text{cmin}} = 0$)



Class Test-3 (Equilibrium Carrier Statistics)



Band Structure of
Material A

Given:

- Intrinsic Carrier Conc = $10^{12}/\text{cm}^{-3}$
 - N_d dopant atoms with E_d near conduction band = 10^{18} cm^{-3}
 - Given $\log_e(10)$ or $\ln(10) = 2.3$
- 1) Draw qualitatively correct D.O.S (E), F-D Distribution(E) and Supply Function(E)
 - 2) Quantitative estimates for p_0 and $E_c - E_f$. Assume $E_f = E_g/2$ (mid gap)

Class Test-4 (Quasi-equilibrium Transport)

Drift Diffusion @ Thermal Equilibrium:

*Example: Exponentially doped semiconductor
w/o any external excitation*

$$N_d(x) = N_{d0}e^{-x/\lambda}$$

$x = 0$	$x = L$
$N_d = 10^{19} \text{ cm}^{-3}$	$N_d = 10^{15} \text{ cm}^{-3}$

Q1) Draw Band Diagram

Q2) Draw direction of drift diffusion current for e- and h+

Q3) Draw J_{net}